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AMERICAN SOAPS.

A COMPLETE TREATISE

ON THE

MANUFACTURE OF SOAP,

WITH SPECIAL REFERENCE TO

AMERICAN CONDITIONS AND PRACTICE.

BY

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Editor of the *American Soap Journal.*

CONTAINING

Many Practical Additions and Suggestions

by a number of successful and well-known Soap Manufacturers, and illustrated by 74 engravings.

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HENRY GATHMANN, 32 Market Street.
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PREFACE.

Notwithstanding a considerable number of books published in this and other countries, and treating on the manufacture of soap, it is an admitted fact that up to the present there existed no work which could serve as a practical guide to the *American* soap maker of the present time. The older works mentioned, without exception, were given almost in their entirety to a description of soaps and methods quite foreign to this country, so that it can be truthfully claimed that this is the first treatise published on the manufacture of soap *as actually conducted in America.*

Having had, during the past three or four years, abundant opportunities to note an urgent demand for a book of this kind, it would seem unnecessary to make the customary apologies for this publication ; but instead it may be well to state briefly the considerations which led the author to adopt a style of treating the subject entirely different from that pursued in other books :

He has endeavored to make a prominent feature of this treatise the absolute freedom from all reference to matters not of *practical* interest to the American soap maker. The manufacture of oils and of alkalies ; the history of soap making ; directions for making soaps which are never manufactured in fact, nor even sold in this country ; the numerous theoretical processes which have failed to give useful results ; long tables and calculations not required in practical work ; and all similar matter which made up a great part of the books previously published ; all these have been touched upon as lightly as possible. A work which attempts to be a history, encyclopædia, and practical guide to the manufacturer all in one, must invariably fall short of its aim, and will consequently be neither one nor the other.

An equally prominent feature of the present work are the explanations and reasons given for all the operations performed in the soap factory. Mere formulas for making certain soaps (and very few good ones have heretofore been printed), can be of little use to any one ; they can be understood and used properly only by

those who already are possessed of more information than the formulas reveal; while those who wish to gain additional knowledge will find very little of it in an arbitrary formula. Moreover, there are many operations which *must* be learned under proper guidance and by subsequent intelligent observation; in such cases unexplained formulas are worthless at best. The simple possession of the finest collection of formulas is evidently no more sufficient to make a competent soap maker than a choice collection of prescriptions will make a physician, for in both cases formulas are only the smaller part of the required knowledge. This book is therefore intended to be *read*, rather than as a book of formulas.

Again, comparatively few soap makers are familiar with general chemistry, and useful as a knowledge of this science often is in the soap factory, it must not be forgotten that "a little knowledge is a dangerous thing." Therefore, instead of forcing on the readers useless fragments of an intricate science, or confusing them by language to which most of them are not accustomed, this treatise has been written in plain, every-day terms. References to chemistry are contained in a separate "Appendix" to which the reader may refer, if he likes; but if he does not, the practical contents of the book will still be perfectly plain.

Certain chapters on subjects which once were of great interest, but are no longer so on account of later improvements, have for years been reprinted from one book on soap into the next one, and so on. Few soap makers are without one or the other of these books, and those interested in purely theoretical methods, or in such as are no longer used, will have no difficulty in finding the desired information, so that it was not considered necessary, nor even desirable, that they should be again reprinted to encumber these pages.

There are, on the other hand, a great number of practical suggestions and explanations which are of value to the soap maker, but have never before appeared in print. Of these the writer has endeavored to embody as many as possible in this work, in place of the antiquated subjects omitted.

Lastly, the author takes great pleasure in acknowledging his indebtedness for numerous valuable hints and suggestions to practical soap manufacturers, and especially to Messrs. George A. Schmidt, Melzer Bros., F. B. Strunz, and others.

HENRY GATHMANN.

CHICAGO, ILL., 1893.

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PART I.

A Few Words to the Practical Soapmakers.

Among the contents of this book the practical soapmaker will recognize many statements of facts which, through his own practical experience and observation, and through his previous study of the subject, have become perfectly familiar to him ere this. If they appear here, it is of course not with a claim for novelty, but for the sake of completeness, and for the benefit of those less well informed.

If he read the book attentively, and from the beginning to the end, he will undoubtedly be amply repaid for his trouble by finding in it also many useful suggestions which are new to him, and whose value he will readily admit without question. It being in the nature of the case that such suggestions must be distributed over many different pages and chapters, the soapmaker should not fail to read *all* of the book, including also such chapters as may treat of soaps which he does not make, especially so since there has been absolutely no useless padding added to unnecessarily swell the number of pages.

The principal object, however, of especially addressing the practical soapmakers in these few lines, is to remind them of the fact that the time has not come yet when even the most expert will agree on all the practical points involved in their art, even under the same conditions otherwise, and that circumstances vary on every hand. It is therefore fully expected that the experienced soapmaker will find in the practical part of this book more or less that he will see proper to disagree with. It is his privilege to criticize this work, but he should not do so until he has carefully read the whole book, nor without considering that this treatise is based on the actual experience of many of the most expert in the art; those practical soapmakers, therefore, will not be doing justice to their own best interests who refuse to at least give the

most serious thought to all those points expressed that happen not to be in accord with the opinions they have held up to the present.

In regard to the figures named here and there as to strength, quantity or time, every soapmaker knows from experience that there is hardly an operation carried out in the factory which is not subject to changes under varying circumstances; the arrangement of the kettles and of the other machinery, changes in the purity of the raw materials, climate and local conditions, as well as the greater or less degree of care and time that can be devoted to the quality of the product, and the state of the market—all these have more or less bearing on the special figures to be inserted into the several formulas. It is therefore insisted above all that in the elucidation of principles, as much as in the formulas, lies the value of this work, if the author may make bold at all to presume that it has any.

Introduction.

Although the art of soap making reaches so far back into antiquity that its early beginnings are now merely matters of conjecture, it is only in the last hundred years that the principal features of the art, as it is conducted at the present day, were developed.

It is now just a century ago (1791) that Leblanc, a French chemist, discovered and patented a process of manufacturing soda from common salt, and this invention, more than any other influence, brought about great changes in the manner in which this industry has since been conducted.

Leblanc's discovery of artificial soda.

Previous to the manufacture of this artificial soda, the alkalies employed by the soapmaker were derived mostly from the ashes of various plants. Special forms of such crude alkalies much used formerly (and still employed to a limited extent at the places of their production) are *barilla* and *kelp*. The former is a crude soda derived from burning plants that grow along the shores of the Mediterranean; the latter is a similar material made in more northern countries by burning several varieties of seaweeds. Ashes from plants growing in places more distant from the sea contain mostly potash, instead of soda. Leblanc, whose invention has been of incalculable benefit to mankind, died in the greatest poverty in the year 1806.

Fifty years later (1841) another great discovery, and one of considerable influence in the soap industry also, was made by Chevreul—like Leblanc, a celebrated French chemist—who at that time discovered the true composition of fats, and who was first to explain correctly the nature of the chemical action by which soap is formed from fat and alkalies. His discovery has been of the greatest practical value to the fat industry and all the allied branches. Chevreul died only a few years ago (1889) at the

Chevreul's discovery.

remarkable age of 102 years, and, unlike the unfortunate Leblanc, had the satisfaction of at least reaping a substantial reward for his numerous useful labors.

To the achievements of these two men, therefore, is due in a great measure, directly and indirectly, the enormous development of the soap industry at present. It is true that other processes for the artificial manufacture of soda have since been discovered and come into use, besides the Leblanc process, but this was at a time when the Leblanc alkali had already modified the manufacture of soap to a very great extent.

Soap making in the United States 50 years ago.

Considering then the comparatively recent date of these two far-reaching discoveries, it is not surprising that—particularly in the United States—the manufacture of soap should have undergone great changes in the last fifty years, especially as it is only since 1839 that cocoanut oil came into use for soap making, while cotton seed oil was not introduced until about fifteen years later. Fifty years ago the American methods still greatly resembled those employed in England, but since that time they have become materially changed. The New England States were then the principal center of the American soap industry, and the soaps made from the raw materials and with the appliances available were in many respects very different from those of the present time. Filling materials were practically unknown, and the "settled" soap was simply run into the wooden (lift) frames and crutched for hours until it became thick from cooling; or it was finished by boiling down, or perhaps by "running." The soap was ladled by hand from the kettles into the frames, or into buckets or tubs, which were then carried to where the frames were placed, to be emptied into the latter. The soap kettles were made of cast iron bottoms, to which a wooden curb was fastened by means of wedges and cement, and the composition of a cement that would prevent leakage for any length of time was then considered a great trade secret! Through the wooden curb just mentioned a pipe entered, which reached down to near the bottom of the kettle and by means of which the waste lye was run off. The kettles were heated by open fire and the contents were stirred and kept from burning or adhering to the bottom by means of a long iron rod, flattened at the end. The lye was made either by causticizing soda ash with lime or by leaching wood ashes, for caustic soda did not become a commercial article until the beginning of the present century, and was but slowly adopted for use in

soap factories at first. The first pressed cakes of laundry soap are said to have been brought on the market by B. T. Babbitt, of New York. At that time the soapmakers also were much more generally manufacturing candles, lard oil, potash and soft soap than they are now.

When the civil war broke out rosin became very scarce, and was, therefore, largely substituted by simply adding water to the soap; silicate of soda was used similarly in some cases, but its use had not yet become general at that time. Most forms of adulterations of soap have become known only within the last half century.

More recent improvements.

After the war, when rosin was again more plentiful, there was a tendency at first to return to the old methods of making unfilled settled soap, but soon after (some time in the sixties) the process of hardening resin soaps by means of sal soda was first introduced; its first application is ascribed to A. Van Haagen, then of Philadelphia.

Gradually the process of recovering glycerine from waste soap lye had been perfected in England, and began to be practiced and improved upon in our large soap factories here, until now a crude glycerine is furnished to refiners by quite a number of soap factories, operating by various methods.

The early beginnings of soap powder manufacture also fall into this period, and at the present date have developed into a by no means inconsiderable industry.

About twenty years ago white floating soap was first brought on the market by Proctor & Gamble, of Cincinnati, Ohio.

Naturally, during these fifty years a great number of improvements in the equipment of factories were also made, and a large number of patents were secured on machinery and processes relating to soap making. Few, if any, of the patented processes, however, have proved useful.

At present the best grades of soap made in America are at least equal to those made anywhere in the world, while in regard to mechanical facilities for operating on large quantities, with the greatest economy of time and labor, this country is acknowledged to take the lead.

CHAPTER I.

The Nature of Soap.

The soaps of commerce being essentially products of fats and alkali, a few preliminary remarks about these ingredients will not be out of place before considering the nature of soap itself.

ALKALIES.

The term "alkalies" is employed to designate a certain small group of chemicals which are characterized principally by the following properties: They are caustic (that is to say, corrosive, destructive, on animal tissues), soluble in water, combine readily with acids—whose properties they neutralize in so doing—and turn certain vegetable yellow colors into red. The alkalies, in the order of their importance to the soapmaker, are Soda, Potash, and Ammonia. (To this group also belongs Lithia, which, however, is of no special interest to the soapmaker). When an acid of any kind is subjected to the action of an alkali, there is formed a new compound—chemically called a "salt"—which will be neutral, i. e., neither acid nor alkaline in its effect on animal tissues or on vegetable colors. (See Appendix, Note 1.) Soap is, chemically speaking, such a salt. Alkalies defined.

The alkalies may be either "carbonated" or "caustic." Carbonated soda, for instance, is soda combined with carbonic acid, as in the case of ordinary washing soda, or soda crystals. When the carbonic acid is withdrawn from the latter by any suitable means, such as quicklime, the previously "carbonated" soda becomes "caustic" soda. Carbonated and caustic alkalies

Alkaline Earths: Lime and Magnesia are similar to, but not true alkalies; they belong to a class of chemicals to which has been given the name of "alkaline earths," because their properties are partly identical with those of the true alkalies, while on the other Alkaline earths.

hand they range themselves with the true earths. Their compounds with fatty acids are soaps in a certain sense, but being insoluble in water, cannot be used for the purposes of the ordinary soda or potash soaps. (See Appendix, Note 1.)

FATS AND FATTY ACIDS.

Composition of fats and oils.

The numerous fats and fatty oils of animal as well as vegetable origin, such as tallow, bone grease, lard, train oil, palm oil, cotton seed oil, cocoanut oil, etc., are neutral substances, which may be decomposed by the aid of a current of superheated steam, or by other suitable means, into two distinctly separate portions: a mixture of so-called "fatty acids" or "sebacic acids" on one hand, and the familiar substance "glycerine" on the other. When a fat has been so decomposed into its constituent parts, the fatty acids in their uncombined state exert a distinctly acid effect on other substances, as may be witnessed, for instance, in the corrosion of metals by lubricating greases containing free fatty acids. The fats are insoluble in water, melt and burn readily, and cause permanent grease stains if applied to paper; they combine with alkalies, alkaline earths, etc., to form various compounds. Glycerine is a neutral substance, formed by the combination of water with the "glyceryl" contained in neutral fats.

Each fat, as it is found in nature, contains several different fatty acids (combined with glycerine), the principal ones of which are named respectively stearic, palmitic and oleic acid. Tallow, for instance, may be separated by pressure, suitably applied, into a liquid and a solid portion, the former being principally olein (oleic acid combined with glycerine) and the latter a mixture of palmitin and stearin (palmitic and stearic acid, combined with glycerine). Oleic acid is liquid at ordinary temperatures, congealing only when cooled to about 40° F. Lauric, palmitic and stearic acids are solid, melting at about 110°, 144° and 156° F., respectively. According as the more solid fatty acids are present in larger proportion the different fats themselves will be more solid.

The fatty acids of any fat desired may be most easily procured for examination by dissolving some soap, made of such fat, in water, and adding a little sulphuric acid, whereby the fatty acids are displaced from their combination with the alkali and rise—mixed with each other in proportions according to the nature of the fat from which the soap was made—to the surface of the solution. (See Appendix, Notes 2 and 3.)

The "mineral" and the "essential" oils are entirely different substances in composition from the fatty oils; they have hardly anything in common with the latter (except their oily appearance and ready inflammability), containing neither fatty acids nor glycerine, and are incapable of forming soaps. Mineral and essential oils.

SOAPS.

The Formation of Soap: As has been said in the foregoing, a neutral compound is the result when an acid and an alkali are caused to chemically react upon each other. This is true in the case of the fatty acids as well as in that of the stronger mineral acids—such as sulphuric and nitric acids—and when a quantity of any *fatty* acid is boiled together with an equivalent amount of a solution of caustic alkali in water (lye), the product will be the neutral compound "Soap." It is not, however, necessary, or even desirable, to decompose the fat into fatty acids and glyceryl (or glycerine) before boiling with lye, in order to make soap, for acids naturally have a stronger affinity for alkali than for glyceryl, and consequently when a neutral fat is boiled with a caustic lye, the fatty acids thereof combine with the alkali and separate from the glyceryl, which in turn combines with the water of the lye and is, at the end of the operation, found in the kettle as glycerine (which is uncombined with the soap and simply mechanically mixed with the mass); in boiled soaps the glycerine is generally separated, together with the waste lye in which it is dissolved, in the next stage of the manufacture. In combining to form soap, as described, the fatty acids as well as the alkali lose their identity, so to speak, for the soap is not corrosive as was the alkali, nor is it greasy and insoluble in water, as were the fatty acids; from this it is evident that soap is not simply a mixture of alkali and fatty acids, but a true chemical compound. Here now it must be remembered that, while mixtures may be made in any desired proportion of one ingredient to the other, chemical compounds are formed always in absolutely fixed proportions. Thus a certain amount of fat requires a certain amount of alkali to transform it into soap; if less alkali than required be used, a part of the fat will remain simply mixed in the soap, unsaturated by lye. and the product will be but incompletely soluble in water and of a greasy character; if more than the required amount of lye be employed, it will—unless removed by subsequent treatment remain in the soap as free alkali, and make the product sharp and caustic in the proportion

Combination of fats and alkali.

Definite proportions of fat and alkali required.

of the excess present. When made properly, the fatty acids of the soap balance (neutralize) exactly the causticity of the lye, and the soap is neutral. The process of soap-making, therefore, consists in its principal features in bringing fat and alkali into direct contact with each other by suitable means, whereby the fatty acids combine chemically with the alkali to form soap, glycerine being at the same time set free from the fat and either remaining in the soap or being removed by subsequent treatment, according to the particular process of manufacture adopted. (See Appendix, Note 4.)

Necessity and effect of water present in soap.

The Water in Soap: There is also required, for the proper formation of soap, a certain percentage of water which enables the particles of soap to form a compact and yet readily soluble mass. Other things being equal, soap is more easily soluble—and thereby more rapidly effective—in the proportion that it contains a greater percentage of water; this proportion, of course, must be within reasonable limits in the product to be marketed, as an excessive amount would be in the nature of a deception from the purchasers' standpoint, besides being sure, by subsequent evaporation, to render the soap unsightly and too light in weight. Freshly made soap washes quickly, but is apt to waste away in consequence of its greater solubility on which this rapid action depends. On drying it becomes more economical for use, but a certain amount of water (bound in the crystals of soap) is retained under all ordinary circumstances, even if the soap has been kept for years and appears exceedingly dry. When well dried, soda-soaps become very hard and difficult to dissolve, and are then rather unsuitable for ordinary use. The amount of water contained in commercial hard soaps varies greatly, from say about 10 or 12 per cent. to 35 or 40; a greater proportion than the latter may be said to exceed the quantity really permissible for a fair commercial article.

Various ingredients of soaps.

Other Ingredients in Soap: Soap proper contains, as described above, fatty acids, alkali, and a moderate amount of water; but certain other additional substances generally enter into the composition of the commercial products, for various purposes—legitimate and otherwise. Among these may be mentioned: Rosin, as a partial substitute for fats; carbonate of soda, and other salts, for hardening and rendering the soap more detergent; sand, tripoli, pumice stone, and like substances, which aid mechanically in the process of cleaning; glycerine, etc., for giving the soap greater emollient properties; sugar, alcohol and glycerine, for transparency; sulphur, tar, carbolic acid, and the like, for medicated soaps;

colors and perfumes of many varieties; silicate of soda, talc, starch, mineral soap stock, and other cheapening materials, etc., etc. (For further particulars on the "Filling" materials see Chapter IV.)

The varying structure of soaps made by various methods.

The Structure of Soap: On a casual observation, soap appears to be a perfectly homogeneous mass. But on examining it more closely it will be found that the various soaps present considerable differences in their structure, depending on the manner in which they were made. Cold-made soaps are the only ones which present a simple aggregate of microscopically small crystals, formed by the compounds of the different fatty acids with the alkali. Milled soaps have a very dense, even, grainy texture, caused by the peculiar action of the machinery on the soap, which may have been made by boiling or (more rarely) by the cold or half-boiling process. Boiled soaps, if framed hot and without filling, will crystallize on cooling, the stearate of soda crystallizing out from the more slowly congealing oleate of soda, the grain formed by this process being more or less modified by the temperature of framing, by the materials used, and by the size of the frames. If the same soaps are crutched until they are reduced to a lower temperature, these crystals will be less plainly developed, or at least will be distributed more evenly through the mass, and therefore be hardly noticeable. If filling is crutched in instead of framing the soap in its pure state, it will in most cases destroy the crystallization and cause an almost homogeneous texture.

Decomposition of soap in use.

The Effect of Soap in Washing: Just in what manner the soap exerts its detersive action has been a matter of much speculation and research. The generally accepted theory regarding this subject is that, when soap is dissolved in water, it undergoes a peculiar form of decomposition by which the neutral compound is split up into two parts—an alkaline soap and an acid soap. The alkaline soap is soluble in water and is believed to act by emulsionizing * the particles of grease contained in the articles to be cleansed, so that the dust and dirt attached to them can be easily removed; the acid soap is almost insoluble in hot water, but more so in the soap solution, and, according to this theory, contributes

* In the presence of certain substances, as alkalies for instance, a mixture of fat and water will form an "emulsion," *i. e.*, the fat is divided into microscopically small globules which float in the water, giving the mixture a milky appearance.

to the cleansing effect by the particles of dirt attaching themselves to the flakes of acid soap and thus being rinsed off with the latter. (See Appendix, Note 5.)

Effect of hard water in washing.

The Water Used in Washing: The condition of the water used in washing has much to do with the action of the soap. Hard water, containing compounds of lime and of magnesia, has a peculiar effect on soap, as the sulphuric or the carbonic acid forming part of the compounds named are capable of decomposing it, combining at the same time with the alkali which it contains, and setting free the fatty acids, which then combine at once to form *insoluble* soaps with the lime or magnesia (see App., Note 9). In such case the lime soap (or magnesia soap) formed by the reaction here described, being insoluble in water, appears in minute flakes, which adhere to the meshes and fibres of the cloth and produce a yellow discoloration and ultimately a disagreeable odor of the clothes. It is a matter of every-day observation that soft water in washing cleanses more readily and leaves the clothes whiter than when hard water is used, and when soap is used in hard water the insoluble flakes of lime or magnesia soap are readily seen. (The alkali of the soap, together with the acid of the lime compound which causes the hardness, forms a new compound which remains dissolved in the water and is of no especial harm.) As gradually all the lime or magnesia of a hard water is so decomposed by soap, the hardness of the water decreases. So also has the *free* alkali in a soap a tendency to precipitate the lime (by combining with the carbonic acid contained in the carbonates of lime and magnesia generally present in hard waters), and consequently to neutralize the hardness; it thus happens that a soap which, on account of the free alkali contained in it, is very sharp when used in soft water, may be much less so, or even quite neutral, when used in hard water; in this case a soap containing a small excess of caustic strength is more serviceable than a neutral soap. (See App., Note 10).

Effect of alkaline soap on hard water.

Effect of temperature of water in washing.

The temperature of the water used for washing has as much influence on the efficiency of a soap as has its degree of hardness. The hard soap used almost exclusively in the households of this country is but imperfectly soluble in cold water, the soap formed by the combination of stearic acid and soda being soluble only in water at a higher temperature. Tallow and grease are especially rich in stearine, and when the soaps are made of these fats the use of cold water entails a loss of soap for the reason just given; but

further than that the process of emulsionizing the fatty and greasy matter to be removed by washing, as referred to above, takes place very imperfectly only when the water used for washing is cold. Hot water, therefore, it is evident, is in every way preferable. Aside from the points involved in the before mentioned theory on the action of soap, the great penetrating properties of soap solution and its lubricating qualities come into play in washing, and contribute largely to the thorough effect and prompt action.

Various Detergent Substances: Besides soap, a number of substances possessing cleansing properties have been used for detergent purposes, and in the case of a few are sometimes incorporated into soap. In the earliest times wood ashes were used for cleansing, owing to their contents of potash. It was then also discovered that the action of lime increased their efficiency (by causticizing them). From this undoubtedly arose the invention of soap making, by combining the caustic lye with fats.

Various detergent substances.

In some countries the juices of a great variety of plants are utilized for cleansing purposes, the saponaceous principle being variously extracted from the roots, barks, leaves or fruits of these plants, which in a few cases form the subject of a somewhat limited commerce. *Quillaia bark* from Chile, for instance, is sometimes used for washing silk; a bulb known in California as *amole* is sometimes employed as an ingredient for soap making, and was used for cleansing purposes by the Indians of this country before they learned the use of soap from the white man. *Yucca* is another plant (a native of Virginia and Carolina) which has detersive properties. Among the other substances to be mentioned in this connection are Fuller's earth and China clay, which have the property of absorbing greasy matters; and the alkaline substances, borax, ammonia, silicate of soda and carbonate of soda, also benzine, gasoline, ox-gall, and so forth.

CHAPTER II.

Fats and Oils.

FATS AND OILS IN GENERAL.

Composition o fats and oils.

The oils and fats, of both vegetable and animal origin, form a class of substances which are lighter than water, practically insoluble in the latter, unctuous to the touch, and cause permanent grease stains on paper; they are for the greater part very similar to each other in their chemical composition and behavior. The pure fats and oils consist entirely of fatty acids and glycerine, or to be more exact, they lack only a small percentage of water in order to admit of being resolved completely into these substances. (See App. Note 14.) Thus 100 lbs. of fat may be made into about 97 lbs. of fatty acids and 8 lbs. of glycerine, a total of about 105 lbs., showing a gain of about 5 lbs., which is represented by the water required besides the fat to form these new combinations. Nearly all the fixed oils and fats are almost colorless and odorless when in a pure state, the color and odor of the crude fats and oils being due to the admixture of certain foreign coloring and other matters. Leaving, for the present, out of consideration this small admixture of foreign matters, it may be said that the features distinguishing the numerous fats and oils from each other consist in the varieties and the proportions of the different fatty acids present in each fat; and by studying the peculiarities of the small number of the more important fatty acids, we learn also to better understand the reasons for the peculiarities—from the soap makers' point of view—of the different fats of which they constitute the largest portion. As said before, two or more different fatty acids, combined with glycerine, are present in every natural fat, and every fat therefore is a more or less complex body.

Among the fatty acids only a small number are of practical interest to the soap maker, the others being found in very small proportions only in any fat. Very important are Stearic, Oleic, and Palmitic Acid, and also Lauric and Myristic Acid. (See App. Note 6.)

All fatty acids combine readily with the alkalies. In their free state this combination takes place almost instantaneously, even if the lye be carbonated (that is to say, if it be made of alkali combined with carbonic acid, as distinguished from caustic alkali). The neutral fats, on the other hand, require boiling for hours with lye, which must be caustic in order to completely saponify them.

Stearic Acid and Stearin: When perfectly pure, stearic acid is devoid of odor, color, and taste, easily soluble in alcohol, but insoluble in water. Its melting point is about 156° F., at which temperature it forms a colorless oil; on cooling again it forms a white, brittle, crystalline mass. It is present as stearin (stearic acid combined with glycerine) in nearly all fats, and being of a very solid consistency, the fats containing a considerable proportion of it, as well as the soaps made therefrom, are naturally more solid than those richer in the other varieties of fatty acids. The hardest fats, ordinarily known as tallows, contain an especially high percentage of stearic acid, respectively of stearin. Fats rich in stearin are better adapted for making soap containing rosin than the softer fats and oils. Stearin is a neutral substance, dissolving but sparingly in cold alcohol and, like stearic acid, is solid at ordinary temperatures. Soap made from stearic acid (or stearin) and soda, is very sparingly soluble in cold water, but quite soluble in hot water.

Palmitic Acid and Palmitin: These have a great resemblance to stearic acid and stearin respectively and, like the latter, palmitin is a constituent of most vegetable and animal fats, being especially abundant, however, in palm oil. Palmitic acid is somewhat lighter than stearic acid, melts at a temperature about 12° F. below that required for the latter, and forms at ordinary temperatures an odorless, tasteless, colorless, brittle and crystalline mass. It is insoluble in water, but easily dissolved by boiling alcohol.

Palmitin is neutral, insoluble in water, and almost insoluble in alcohol; at ordinary temperatures it is a solid body, melting at a somewhat lower temperature than stearin.

Oleic Acid and Olein: Like the preceding two fatty acids, oleic acid is found in most of the natural oils and fats. It is insoluble in water, but readily soluble in alcohol, and when pure it is devoid of odor, taste, and color. It differs greatly, however, from stearic and palmitic acids in being liquid above 39–40° F. (below that temperature it is hard and crystalline), and a large proportion of oleic acid in any fat tends to make it more fluid.

Olein differs from stearin and palmitin in being much more soluble in alcohol, also somewhat slower to combine with alkalies to form soap. The soap it forms with the alkalies is much softer and more easily soluble in water than stearin soap.

Lauric Acid: This is a fatty acid found in cocoanut oil and some other oils. It melts at about 110° F., forming a thin oil which, on cooling, turns into a crystalline mass.

Laurin (=Laurostearin) melts at about the same temperature, but on cooling it forms a solid, brittle mass, not unlike stearin. It it easily saponifiable.

Myristic Acid: This fatty acid also is found in cocoanut oil and in some other fats. It melts at about 129° F. and when cold forms a solid, crystalline mass.

Linoleic Acid; Ricinoleic Acid; and Butyric Acid: are among the remaining fatty acids which deserve to be mentioned; they are characteristic of linseed oil, castor oil, and butter respectively.

Margaric Acid, Cocinic Acid: In the older text books mention is frequently made of margaric acid; this was at one time the name of what is now known as palmitic acid; then it was applied to a supposed newly discovered fatty acid. Later it was held that the substance then known as margaric acid was really only a mixture of stearic acid and palmitic acid, while at present the existence of a special margaric acid is again affirmed by later investigators. So also is cocinic acid a mixture of other fatty acids (lauric and myristic), and not, as was formerly believed, an independent acid.

As was said in the foregoing, all fats are mixtures of various compounds. Thus, tallow is a mixture of stearin, palmitin and olein. Bearing in mind the peculiarities of each of these, as above described, it is readily seen why melted tallow, on being slowly cooled, may be caused to separate into a solid and a liquid portion; the stearin and palmitin solidify, at a temperature at

which the olein still remains liquid. This fact is practically utilized in the manufacture of many products, such as the so-called oleo-oil for artificial butter, etc., the liquid olein being separated from the warm fats by filtering it, under pressure, from the solidified stearin and palmitin. In the natural oils and fats the solid portions may therefore be considered as being dissolved in the liquid part, and on cooling slowly the stearin, etc., separate out from the olein, etc., partly by solidifying on account of the low temperature, and partly by crystallizing.

Effect of the various fatty acids on the soap.

It must not be supposed, however, that a fat acts in every manner *directly* in accordance with the peculiar characteristics of its constituent parts. For instance, it was stated above that stearic acid melts at 156° F. and palmitic acid at 144° F.; a mixture of equal parts of each might be supposed therefore to melt at 150° F.; or itmight be supposed that at 150° the palmitic acid alone would melt, leaving the stearic acid solid. But as a fact, the mixture melts at 134°—a lower temperature than would suffice to melt either one of the ingredients singly. Furthermore, regarding their action in soap making, the fats have a tendency to communicate to a certain extent some of their properties to each other; an oil, for instance, which combines with difficulty only with alkali, will do so more readily when mixed with a more easily saponifiable fat.

On the whole, however, it is safe to select fats for soap making according to the characteristics they possess singly, with a view to counteract extreme effects of one fat, by the addition of another fat known to give opposite results. For example, soap from tallow alone forms a lather slowly, but the lather remains a long time; and soap made from cocoanut oil alone lathers very readily, but the lather formed is of very short duration; but if both fats are used together, they quickly yield an abundant and lasting lather. Tallow soap, during the boiling and later operations, has a very thick consistency and becomes solid while still very hot, so that for carrying out certain operations requiring fluidity of the mass, an oil like cocoanut oil, which gives a soap of thin body while hot, is a valuable aid in the process of manufacture. Again, some oils form soaps which are too easily soluble for some practical uses, and in such case the addition of fats forming less easily soluble soap is indicated. These considerations will be further carried out in detail in the following description of the fats used in soap making, and also in a special chapter devoted to the selection of stock for soaps of different character.

Rancidity of fats.

Rancidity of Fats and Oils: When fats are exposed for some length of time to the influence of the air and light, they absorb oxygen from the atmosphere, and a portion of them is split up into fatty acids and glycerine. The free fatty acids are then gradually decomposed still further into another series of *volatile* fatty acids of a rank odor, so that rancid fats are characterized by an offensive smell, and contain more or less free fatty acids. The presence of moisture, either in the fat or in the air, seems not to be absolutely required in order to render fats rancid, but like other foreign matters in the fat, it seems certainly to favor the process. Thoroughly purified fat, deprived of water, is preserved much longer and with less difficulty than the natural products in their crude state. (See Appendix, Note 7.)

Adulteration of fats and oils.

Adulteration of Fats and Oils: It very frequently occurs that soap manufacturers buy fats and oils and work them up into soap without close examination, provided they have a good appearance, when these fats upon investigation would be found to contain impurities or adulterations which detract considerably from the *apparent* value of the fat as a soapmaking material.

These extraneous matters may be merely accidental or fraudulent additions, but in either case they certainly merit much greater attention than they are now accorded by most soapmakers, for whatever may be the nature of the impurity, it signifies a loss to the soapmaker in every instance, unless properly allowed for in the price of the material.

Almost too well known to require special mention here is the adulteration (up to the point of entire substitution) of olive oil by cotton seed oil. A similar case is that of lard; a recent examination made in Germany of lard imported from this country showed that out of 110 different lots no less than 77 were adulterated more or less by the addition either of cotton seed oil or inferior qualities of animal fat, so that on an average the alleged lard was only of half its supposed money value.

The lower priced fats, which are of greater importance to our soap manufacturers, such as tallow, grease, palm oil and the commercial fatty acids, escape adulteration no less. One adulteration to watch for in tallow consists of mineral soap stock, which is an unsaponifiable residue obtained from petroleum refineries. Of this material 20 per cent and more may be present in the tallow without injuring its appearance or its consistency to a very great extent, and unless suspected it may not be discovered without a

special test, for a boiled soap made from it would be merely a little softer, while the presence of the foreign matter in the soap would not be easily revealed. Used for cold-made soap a given weight of such stock requires less lye than good tallow, as the mineral impurity does not combine with lye. The soapmaker no doubt prefers buying pure tallow, and possibly add the soap stock to his soap *at the price of soap stock*, to paying for the latter at the price of tallow.

A similar adulteration consists of glucose, of which quite noticeable amounts have been found in commercial tallow and greases.

A still more common adulteration of fats consists in the addition of water which has been incorporated by the aid of some emulsifying agent, such as soda, potash or lime. A very appreciable quantity of water may thus be worked into a fat without being detected, except upon close examination. Not only the weight, but also the solidity and the appearance of the fat are thus artificially "improved." When soda or potash have been employed for the purpose the loss is simply one resulting from the low yield of soap obtained from the fat; when lime is present, however, a double loss results, from the formation of lime soap in the fat, which deteriorates the quality of the soap made from the latter as well as the quantity. HAGER recently reported that a certain lot of grease intended for soap making, upon being closely examined by him, was found to contain 18 per cent of lime soap. After saponifying and "cutting" with salt a voluminous precipitate of lime soap was noticed. He concludes by saying that the presence of lime in the fat need not necessarily be the result of fraud, since it is possible that pork infested with trichinæ had been treated with caustic lime in order to insure against its being consumed as food, and that on rendering the fat the lime was thus brought into it. For the detection of lime soap in the fat he proceeded as follows: The fat was dissolved in a water bath in five times its volume of petroleum and set aside in a temperature of 15° C. (59° F.) In the course of eight hours a precipitate had formed which was collected on a filter, washed out with petroleum benzine and dried between filter paper. The dry residue is the lime soap, which is soluble in hot, but insoluble in cold petroleum.

The partial saponification which is the consequence of adulteration by weak lye will be apparent when the fat is melted

on water, when little or no clear fat is thereby obtained (but a cloudy emulsion instead) if lye is present.

The admixture of cheaper grades of fat to the tallow or grease cannot perhaps be properly called an adulteration, as it lowers the "grade" on which the price is based.

Not exactly an adulteration, but rather an impurity, sometimes contained in tallow, is sulphuric acid which has been used in rendering (for the purpose of destroying the membrane of the suet), and is not always fully removed. Such tallow is apt to be turned yellow in iron tanks, by the action of the acid on the iron. This is more frequently the case with tallow brought on the market by the small country butchers, who have less perfect facilities for rendering than the large slaughter houses. For soap made by the "Cold Process" such tallow is very unsuitable, as the acid present neutralizes some of the lye and thereby causes disturbances in the process, and badly formed soap. Glue and albuminous matter are frequently found in fats as accidental impurities.

Preliminary test for adulterated fats.

In the absence of facilities for complicated tests, or as a simple preliminary test for fats suspected of adulteration, the following proceeding will often give useful indications concerning the purity of the fat: A fair sample of the fat is melted and placed into a graduated glass cylinder; into the latter is then poured about 35 parts (by volume) of dilute sulphuric acid to 100 parts of fat. After shaking well, let settle. The pure fat rises to the top, while the sulphuric acid absorbs the impurities and settles to the bottom. The graduations marked on the vessel will approximately indicate how much pure fat was contained in 100 parts of the sample. The line between the fat and the precipitate should be distinctly visible, and if it is not so, then the experiment should be repeated with a stronger acid solution. Of course, this test is of no avail in determining adulteration by cheaper fats, and can only be used in regard to such additions as water, lye, lime, flour, etc.

Rendering in soap factories.

Rendering Fats: Throughout the country there are numerous soap factories so situated that they prefer to render themselves the tallow and greases they require, as by this means they are not only placed in position to obtain material of a certain uniform quality, but, under favorable circumstances, to save considerable money besides.

The operation of rendering consists in removing the membranous tissue which envelopes the fat as it is taken from the animal carcass, thus separating the pure fat, and may be carried out in

many different ways; at present the several methods have mostly given way, however, to the uniform system of rendering by steam, under pressure.

Old methods of rendering.

In former times the operation was carried out in open kettles, over open fire, with or without the addition of water, the raw fat having been previously cut into small pieces. This *modus operandi* had several disadvantages, such as failure to extract all the grease, the evolution of an extremely obnoxious odor, great inconvenience in manipulation, etc. Instead of using a high degree of heat for the purpose of rupturing the cellular tissue and liberating the fat, dilute sulphuric acid was partly employed later on in several different ways, as this acid has the property of dissolving and decomposing the membranes; this latter process has since been all but abandoned, and steam is now almost exclusively employed for rendering, as follows:

The application of steam is made either indirectly, by means of open steam-jacketed kettles (see Fig. 1) or by admitting it directly into the material operated upon in so-called digestors (Fig. 2.)

Fig. I.

For the better grades of fat, the jacketed kettles are frequently preferred, as by direct contact of the steam with the fat the membranes are transformed into glue and the quality of the product is

impaired. But while the quality of the fat obtained from rendering in jacket kettles is superior, the quantity is lessened, and for ordinary use digestors are commonly employed.

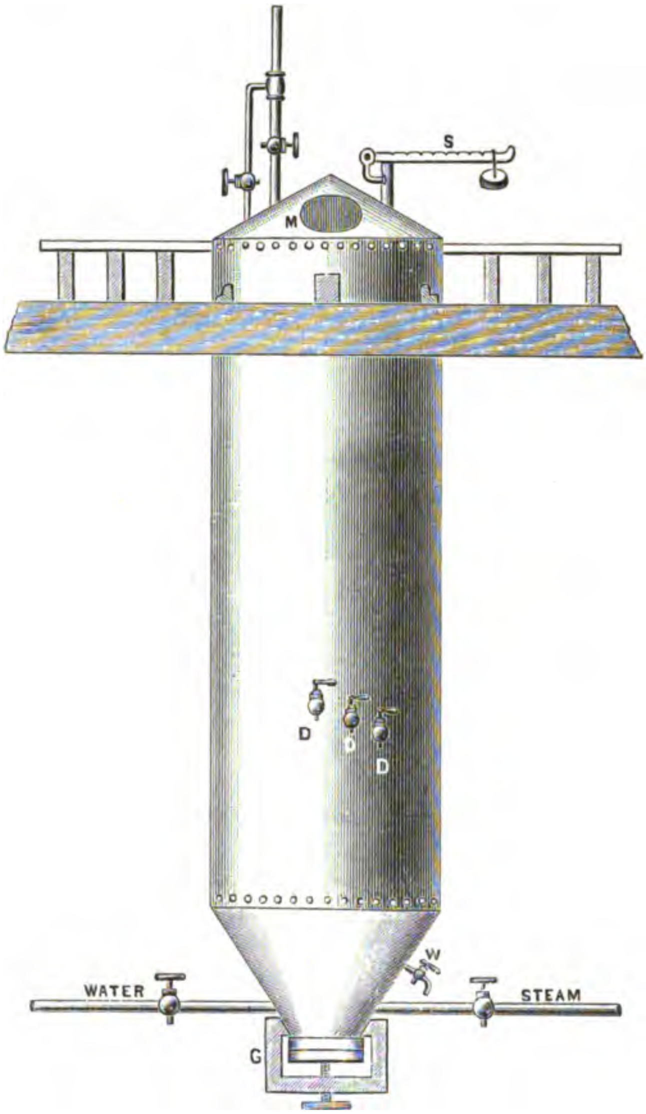


Fig. 2.

The digestors in use are variously constructed as to details, but in their main features they resemble the one here illustrated

(Fig. 2.) This apparatus is a closed, cylindrical tank, made of boiler iron or steel plates, riveted strongly so as to safely allow of a high pressure. In size it varies according to the required capacity, a very common size being 10 to 12 feet high, with a diameter of from 3 to 5 feet.

Referring to the illustration, M is a manhole, through which the tank is nearly filled with the raw material at the beginning of the operation; this done, the tank is closed tightly. S is a safety valve set at the pressure intended to be used. D D D are cocks by which the depth of the melted fat can be determined and the product drawn off after the operation is finished. A steam gauge should be attached to the apparatus, unless a separate steam boiler can be used to supply the steam necessary, in which case the indications of the gauge of the boiler may be relied on. G is the discharge hole through which the "tankage" is removed; instead of placing it at the bottom, as shown in the illustration, it may also be arranged somewhat higher—on the side of the tank—say halfway between the bottom and the cocks D, and just above a perforated diaphragm placed in that portion of the digestor. The diaphragm serves as a support for the fat to be rendered, and at the end of the operation the tankage may be easily removed from it in case the discharge hole is placed on the side; if it is at the bottom, as shown, the diaphragm must be made so as to tilt when the refuse is to be removed. A pipe is also provided on top, for carrying off the obnoxious odor arising from the operation; leading this pipe into the fire-box of the steam boiler, between the boiler and the grate, the odor is destroyed by the flames more effectually than by any other means so far discovered.

When the tank has been charged as before mentioned, steam is admitted through the steam pipe shown at the bottom of the apparatus. The pressure at which the steam is used varies according to circumstances, depending on the size of the apparatus, the nature of the stock to be rendered, and on the time that may be allowed; the higher the pressure used, the less time is consumed, but as a high pressure (and consequently greater heat of the steam) affects the product disadvantageously, it is ordinarily preferable to use rather more time and less pressure; 45–50 lbs. in the digestor is probably a fair average of the steam pressure commonly used, rather less being used for low grades of stock, in order to avoid as much as possible the decomposition of various impurities which would contaminate the product. The time required for steaming,

of course, also varies according to the same circumstances which govern the proper degree of pressure, and may be more or less than 10 hours. During this time the steam continuously admitted condenses into water, which collects at the bottom, and may be drawn off from time to time through the pipe W.

When the operation is finished, steam is turned off and the contents of the digestor are given time to separate and to settle. The melted fat may be drawn off through the cocks D D D, the lower part of the tank being filled with water and with the accumulated refuse. The latter is taken out, pressed to regain the last fat it may hold, and dried to be worked up for fertilizing material.

TALLOW.

Tallow, especially in this country, ranks foremost among the fats used in soap making, as it possesses many properties which make it particularly well adapted and valuable for the purpose; but, unfortunately for the soap manufacturer, there is a steadily growing demand for tallow for the oleomargarine industry and for the lard "refineries," so that the better qualities of the stock are too apt to find their way into these channels. **Properties of tallow in soap making.**

Tallow consists of about one-third its weight of olein and two-thirds of a mixture of stearin and palmitin, and is consequently one of the most solid of fats. The large proportion of stearin also has the effect that the soap made of tallow as the only fat does not lather readily unless the water used with it is hot. (See preceding pages.) Tallow soap gives a very mild and persistent lather, is economical in use, and, while fresh, it is whiter in color in a proportion as it contains more water; on drying it has a tendency to turn yellow, or even brownish, which may be to some extent prevented, however, by bleaching the stock, or by the addition of some vegetable fat—especially cocoanut oil—to the tallow, whereby the drying of the soap is also retarded. Tallow is easiest to saponify when the lye used at the beginning of the boiling is not of a much greater strength than 8-10° B., and even when the lye is used of this strength only, all through the operation, the resulting soap in the kettle will be much thicker and tougher than soaps of other fats would be even when made of stronger lye, and, therefore, containing less water.

Like all commercial articles, tallow varies very much in quality. Its color ranges from white to yellow; the feeding of

the cattle as well as the season influence its hardness to some extent, and the different parts of the animal furnishing it, as also the methods and care used in rendering, and the age of the tallow, are of considerable influence on its qualities. In order to extract as much tallow from the raw fat or "suet" as possible, sulphuric acid, or less frequently alkali, is sometimes added to the fat while rendering, whereby the tissues in which the tallow is enclosed are dissolved or charred, and the fatty matter may be extracted with greater ease. But the chemicals, if used in excess, or if not removed by washing afterwards, are apt to injure the tallow as well as to give rise to unforeseen irregularities if used for making soap by the cold process. The steam employed in rendering is liable to transform the membranous matter into glue, which is then very likely to remain in the tallow. Moreover the moisture, particles of blood, etc., attached to the raw fat, rapidly deteriorate the quality of the tallow, so that the latter is apt to be rancid, unless rendered as early as possible. Considering then that tallow is brought on the market by large slaughtering houses as well as by numerous small city and country butchers, the varieties and qualities are easily accounted for.

Bleaching tallow.

In making soap, the tallow used frequently requires to be bleached in order to produce the clear white color so much admired in certain brands. For simply clarifying the tallow it is sufficient to boil it on water (or open steam) to which some salt and some alum has been added; but this means is not always sufficient for the purpose. Tallow so treated still contains more or less free fatty acids, which attack the iron of the kettle and thereby cause a yellow color of the tallow if the latter is left in an iron vessel for any length of time. The removal of these free fatty acids, which range in proportion from 2 to 10 per cent., is also very important when the tallow is to be used for "cold made" soap.

According to the facilities and the requirements of the case, the process of bleaching is carried out in different ways. A simple process, which purifies and bleaches tallow to some extent, is to heat it just enough to melt it in a tank which is provided with a perforated pipe at the bottom, through which a strong air current is forced into the tallow. The air rising through the tallow agitates it thoroughly and destroys some of the coloring matter; some cold lye is then sprinkled over the tallow through another perforated pipe above the tank, this lye dissolving a considerable amount of the foreign impurities and carrying them down. (This process is

most effective when done at the lowest possible temperature.) Then turn on heat, just enough to separate the lye from the fat. When the fat has been agitated for some time with the lye, alum is added (about 1 pound to 2– 3,000 lbs. of stock), which combines with, and precipitates the glue contained in the tallow. The mass is then allowed to rest and the impurities settle to the bottom. The alum treatment is adapted for most kinds of fat, and should always be used in connection with lye, as the precipitation can be best effected in alkaline mixtures.

Another process of bleaching is carried out with the aid of Fullers' earth. The tallow is heated by closed steam in the kettle, in order to drive out all the moisture; next from 2½ to 5 per cent. of Fullers' earth is added and the mixture stirred (or agitated by blowing in air as described) for fifteen minutes, during which time the temperature of the tallow is raised to 220–230° F. The kettle is then covered and the mass allowed to settle for from six to twelve hours, when the bleached tallow may be run off from the impurities that have settled out; or a filter press may be employed to separate the Fullers' earth from the tallow.

Other bleaching processes will be described in the succeeding pages and may be employed for tallow with more or less success.

GREASE.

Definition of "grease."

The term "grease," as used commercially, comprises various fatty matters of animal origin, that cannot be classed among the distinctive products like tallow, lard, neatsfoot oil, etc "Grease" is extracted from bones, hides, the refuse of kitchens, hogs that have died by being smothered or frozen in transit, and from those parts of all classes of animals which do not yield fat that might be classed with tallow or lard. Obviously then, there are very many grades, varying in quality from fresh, white, and comparatively hard grease—which is better for soap-making purposes than the lower grades of tallow—to dark, soft and rancid grease which may be hardly fit for soap making. Generally speaking, grease ranges itself along with tallow in its properties for the manufacture of soap. It contains the same fatty acids as the latter, but olein is present in larger proportions as the grease is softer and, of course, the solid stearin and palmitin are correspondingly less, so that grease has a lower melting point than tallow.

Properties of grease in soap making.

The result is that soap made from grease is softer, and also that grease saponifies somewhat less readily than does tallow.

Being generally less fresh and pure, and affected by a disagreeable odor, grease is not adapted for making soap without boiling, as the impurities and the odor must be removed; the free fatty acids and unsaponifiable impurities in rancid grease make even a fair result by the cold process simply impossible. Besides the soap from grease is darker than that from tallow.

Grease generally, and especially bone grease, is frequently found to contain a considerable quantity of gluey matter and free fatty acids; occasionally the proportion of glue is so large that the stock can scarcely be made into soap at all. Saponified alone it forms a thin soap which is sometimes difficult to separate from the waste lye by the usual means of salt, although the grease may appear to be thoroughly saponified. The soap mass then forms an emulsion and may even have a sharp taste as if an excess of lye were present. By continued boiling, however, this sharpness will disappear, and when thoroughly saponified the soap may be separated by salt without trouble.

As free fatty acids combine very readily with lye which is not caustic, rancid grease is frequently employed with advantage for using up the strength of partly exhausted lye, whereby the carbonate of soda in the lye is saved also.

White Grease is made chiefly from the whole animals, with the exception of the intestines. The latter are rendered separately and yield *Brown Grease*. *Yellow Grease* is made by packers, from all their refuse materials, and such hogs as may die on their hands. *Tallow Grease* corresponds to the yellow grease of the hog packers.

Bleaching grease. Dark grease may be bleached, and its smell at least partly removed, by adding a small quantity of saltpeter to the melted grease and agitating; the saltpeter is then neutralized by carefully adding enough sulphuric acid to decompose it. A dirty scum is precipitated and the grease thereby becomes lighter in color. Another bleaching process for dark grease is as follows: Melt the grease together with an equal weight of salt brine of 15° B., to which about two pounds of alum to 1,000 lbs. of grease may be added to remove the glue, and boil for a quarter of an hour; let settle over night and draw off the clear fat from the sediment, into a wooden vessel, or a lead-lined tank. When the fat has cooled down to about 100° F., add to every 1,000 lbs. a bleaching fluid made as follows: 5 lbs. bichromate of potash (or bichromate of soda) dissolved in 15 lbs. of boiling water; add 20 lbs. of fuming nitric acid of 22° and 2½ lbs. sulphuric acid of 60° B. This

mixture is added in a thin stream to the grease while it is agitated or crutched constantly; the grease first becomes dark, then gradually lighter, until a sample cooled on glass is of a light yellow color. If necessary this process may be repeated. After half an hour's rest 150 lbs. of boiling water are sprinkled over the grease (without crutching) to wash out the acids, and after a night's rest the clear grease is drawn off from the sediment.

LARD.

Composition of lard.

Lard, when pure, consists of nearly two-thirds olein and a little over one-third stearin. It is quite a suitable material for soap, as the product, while fresh, is very white, mild and agreeable in use; but owing to its value for cooking purposes lard is not generally within reach of the soap maker. When old, especially if steam rendered, or made by butchers from scraps saved up till enough are on hand to make it worth while to render them, it is likely to be rancid. Frequently such lard is also dark colored and contains considerable glue. In saponifying, it behaves similarly to tallow, but the resulting soap requires more salt to separate it from the waste lye and retains less water; it is consequently more brittle than tallow soap, and when old it becomes rancid, even more quickly so than cocoanut oil soap. In Europe it is much thought of as a material for soap making, but in this country it has been found less satisfactory than tallow. Whether this is due to a different nature of our lard has not been ascertained, but certain it is that soap made from lard becomes rancid on keeping, or, in the words which a soap maker who had experimented with it extensively spoke in disgust: "The hog always *will* show itself."

Peculiarity of lard as a soap stock.

COCOANUT OIL.

Composition of cocoanut oil.

This oil consists largely of lauric and myristic acid, and some palmitic and other fatty acids in smaller proportion. Owing to this unusual composition, cocoanut oil occupies a place in soap-making materials quite peculiar to itself. Among the features which distinguish it from other fats is the fact that it requires a larger proportion of alkali to form a neutral soap than does any other fat or oil. Furthermore, cocoanut oil soap has the capacity of absorbing large quantities of salts and water, so that by taking advantage of this property the actual amount of soap from a given quantity of cocoanut oil may be made to appear several times as much by the addition of several salts dissolved in water. By rea-

Peculiarities of cocoanut oil.

son of this ability to absorb salt solutions, it is very hard to separate a soap made of cocoanut oil alone from the waste lye in boiling, and if by means of an excessive portion of salt this object is accomplished, the resulting soap will be exceedingly hard and unfit for use, while at the same time the hot waste lye will hold considerable soap in solution which will separate only on cooling; unless this difficulty is overcome by using other fats in addition, only enough lye must be used with this oil to render the subsequent separation of water unnecessary. This is a comparatively easy matter, however, since cocoanut oil is unlike the animal and most vegetable fats in this, that it combines only with strong lyes, and much water is therefore not required in boiling soap with cocoanut oil. Lye of 8–10°, such as might be used to begin the saponification of tallow, does not combine with cocoanut oil at all until it has been concentrated considerably by boiling and consequent evaporation of water. This property of combining readily with strong lye on boiling is not possessed to the same degree by the animal fats; but cocoanut oil is able to communicate it to the latter, so that a mixture of tallow and cocoanut oil, for example, will readily saponify with lye much stronger than 10° B., as required for tallow alone. (These remarks on the strength of lye are based more especially on the lower grades of caustic soda, such as are still used quite largely in some soap factories. With the high grades of caustic, the strength of lye for different fats is of less consequence.)

Peculiarities of soap from cocoanut oil.

The soap formed by cocoanut oil and lye is much more soluble than soap made from animal fats, and it therefore lathers very freely, even in cold water; but the lather is thin and of short duration. For tender skins a continued use of cocoanut oil soaps is irritating, a result due perhaps more to its great solubility and consequent concentrated effect, than to any inherent quality of the oil itself. A disadvantage of cocoanut oil is the disagreeable odor which it develops with age, even when made into soap with other fats, and which is an offensive characteristic of many otherwise good brands. The soap furthermore is brittle, but hard, and cocoanut oil is therefore a very suitable addition to so-called weak stock (fats yielding a rather soft product, as cotton seed oil, grease, etc.) It is more than any other soap soluble in hard water and in sea water, by which property it has earned the name "marine soap." Cocoanut oil, when boiled with lye, forms a soap which is very much thinner than a tallow soap containing the same per-

centage of water, and when it is used in combination with other fats in a soap which is required to have a somewhat thick consistency while in the process of manufacture—as in mottled soap—the contents of the kettle must be boiled with less water than is permissible in a soap made of animal fats alone, in order to produce the requisite consistency. Lastly, cocoanut oil soap is what may be described as "meagre," distinguished from soap made from tallow or lard, which appears much richer or fatter. It will be seen from the above that cocoanut oil soap is in many respects just the opposite of the soaps made from other—and especially animal—fats, and that for many uses a mixture of the two kinds of fat yields a product superior to that of either alone.

Ceylon and Cochin cocoanut oil.

Fresh cocoanut oil has a white color and a peculiar but not disagreeable odor; it melts at about 90° F., but while it grows older the melting point gradually rises, so that old oil does not melt below 110° and over. The oil brought to this country is chiefly of two varieties: Ceylon oil and Cochin China oil. The latter oil is the whitest, and generally in a fresher state than the Ceylon oil which is, or was formerly, nearly always rancid and does not give as white a soap as Cochin oil, even when fresh. At present there are a few manufacturers of Ceylon oil who prepare it more carefully, so that it now sometimes is nearly as white and fresh as Cochin oil. On the other hand Ceylon oil makes a harder soap and binds a larger quantity of water, so that it may be bleached and used instead of Cochin in case of necessity, by using slightly more water to soften the soap. For cold made soap cocoanut oil, and especially Cochin oil, is a favorite material for various reasons, such as its readiness to combine with strong lye, its lathering qualities, its ability to hold large amounts of adulterations, and the beauty of the colors when used in such a soap.

Bleaching cocoanut oil.

For bleaching it, the following process may be used: Melt the oil in a kettle, and add three pounds of salt to 100 pounds of oil, boiling with open steam (or where no steam is available use brine at 15 to 20° B., instead of dry salt) and skimming off the dirty scum rising to the surface until it gradually becomes white. By this operation mucilagenous and other impurities are removed, but if the oil is to be used for cold soap, and the free fatty acids therefore require to be removed also, a quantity of 38° lye should be added first and warmed with the oil (as described under Tallow Bleaching), before commencing the salt treatment, and the soap formed skimmed off. The amount of lye to be used for this pur-

pose depends, of course, on the amount of free fatty acids in the oil; 3 to 4 % of lye will ordinarily be sufficient.

Another method of clarifying cocoanut oil consists in bringing it to a boil with 200 lbs. 8° B. carbonate of soda solution and 100 lbs. water to 1,000 lbs. of oil, and letting it settle. Still another way, recently introduced, is carried out by using a 25° B. silicate of soda solution, of which 20 to 25 lbs. are added to 1,000 lbs. of oil and brought to a boil; then a strong salt solution is at once sprinkled on the surface and a few hours' rest allowed, when the soap formed may be skimmed off and used for some common soap. The clear cocoanut oil should be allowed a few days rest thereafter, in case it is to be used for the cold process of soap making.

Cocoanut oil is made from the fresh pulp of the cocoanut, usually in the country of its growth; or the nuts are shipped as ballast in vessels returning from tropical countries, and worked up into oil in other countries.

Copra oil.

There is, however, another variety of the oil, which is made from the dried pulp, or "copra," in Europe, and to a smaller extent also in this country (New England). It is quite similar to the ordinary cocoanut oil, but not so white as the Cochin or Ceylon oil, and therefore preferably used for colored soaps; this is especially so if the copra was dried by fire, instead of by the sun, whereby it acquires a yellow shade. Still another variety is made in this country by several manufacturers of dessicated cocoanut, who employ the milk of the nuts for this purpose. The oil made from it has a lower melting point and is further distinguished from the ordinary cocoanut oil also by a peculiar odor.

American cocoanut oil.

PALM OIL.

Composition and character of palm oil.

Palm oil ranks next to, and resembles tallow in the quality of soap made from it, particularly when the oil has been bleached. Consisting of palmitin, olein, and considerable proportions of free fatty acids of the same compounds, it yields a firm soap that lathers more readily than tallow soap; but when old, palm oil soap, like tallow soap, becomes hard and lathers but poorly. Even when saponified with weak lye of say 8° B. the soap in the kettle is thick and tough; but stronger lye is used for its saponification in practice. With the exception of tallow, palm oil contains the largest proportion of *solid* fatty acid (palmitic acid in this case) of all the fats, so that soap made from it is of a solid

consistency, even though it readily holds a rather large proportion of water, and lathers freely.

Palm oil is liquid in warm countries, but in cooler climates it has a consistency similar to that of lard, melting at from 80° to 105° F. and over, according as it contains more or less free fatty acids. In color it varies from orange to brown, and sometimes—although not so often now as in former years—even almost black; the odor of the fresh oil is quite pleasant, being not unlike that of orris root, while old oil may have a very disagreeable smell. The odor of the fresh oil harmonizes well with most perfumes and is not destroyed in making soap, unless previously removed in the process of bleaching the oil by chemicals. The addition of palm oil to the stock also causes an improvement in the odor of rosin soaps. Exposed to the air the oil rapidly becomes rancid and pale in color; but the presence of the large percentage of free fatty acids—which is not infrequently found to be as high as one-third of the total—can only be accounted for by the irrational methods of manufacture followed in many districts whence the oil is obtained. Palm oil is the product of the fruits of several species of palms, more especially of that known as *Elæis Guineaensis*, which grows in profusion in West Africa. The so-called palm nut is of about the size of a walnut and consists of a kernel enclosed in an oily, fibrous envelope. The latter yields the palm oil, and from the kernel is made the palm kernel oil so largely used in European soaps, and described hereafter. The ripe nuts are thrown into a hole in the ground, for keeping until the oil is to be made, and in the meantime they seem to ferment slightly, so that they yield an oil of a high melting point or so-called "hard" oil, which naturally contains more free fatty acid than the "soft" oil as made in certain other districts of Africa from the fresh nuts. Little or no care being taken to free the oil from the dirt adhering from storing the nuts in the ground, the oil made as described contains generally quite an appreciable admixture of foreign matter. When sufficient nuts have accumulated, they are boiled to soften the fiber and then bruised and covered up with leaves for twelve hours. Considerable heat is thereby generated spontaneously, and the oil partly runs off and partly is washed and pressed out. The oil is then boiled in order to free it from the water taken up in washing, and thereby assumes a still darker color.

Lagos palm oil is by far the best grade, not only from natural causes, but also because it is made more carefully and less subject

to adulteration. It is therefore less rancid and also has the best color.

The coloring matter of palm oil.

Unbleached palm oil yields a soap of yellow color, but on exposure to the air this color generally fades from the surface of the cake, until at last only a small yellow spot remains in the center. This may be prevented, however, by using some rosin in the soap, which gives it the property of holding the color. Crude palm oil must not be used in soap, however, to an extent exceeding say 15% of the total of the fats used, because in large proportions the color is very apt to stain the clothes in washing, the yellow spots so caused being very difficult to remove from the clothes.

Bleaching palm oil.

For light colored soap the palm oil of course requires bleaching, which then, the coloring matter being destroyed, permits the use of larger proportions of this oil. This process may be performed either by the influence of light and air or by chemicals. By bleaching according to the first named process the odor of the oil is retained, while bleaching with chemicals, unless done with the greatest care and with the smallest amount of chemicals, destroys it. Previous to bleaching the oil it is melted and heated by open steam for thirty minutes or more, or melted on boiling water; after settling and cooling to 125° F. the oil is drawn from the water and sediment. By then heating it to 212° F. and forcing air currents through it by means of a perforated pipe, or by pumping the hot oil through a perforated pipe and letting it fall back into the tank, the coloring matter is destroyed. In the absence of a pump for the purpose a basket may be substituted which is weighted down with a stone and sunk into the oil and drawn up again, so that the oil trickles back into the tank in fine streams; this manipulation is continued till the oil is bleached. Or heating it to about 300° F., or slightly over, and keeping it at that temperature for several hours without agitation will also destroy the color, and the oil will become white, with only a slight brownish tint. The latter process saves mechanical work, but unless there are facilities for bringing the oil to the temperature required by means of steam, it is dangerous, as the kettle over an open fire might leak slightly, and thus give rise to serious accidents.

Bleaching palm oil by the use of chemicals.

The bleaching proceeds much more rapidly, however, and more effectively, by the use of chemicals, as follows: The oil, after being purified by hot water or by steam, as above described,

and cooled to 120° F., is run into a wooden vessel or into a lead-lined tank (the casks in which the oil comes are suitable), and for each 1,000 lbs. are added a saturated solution of 8 lbs. bi-chromate of potash, dissolved in boiling water, and 20 lbs. strong hydrochloric acid, and say 4 lbs. of sulphuric acid, the mass being well agitated for ten to fifteen minutes, by any suitable arrangement; during this time the oil first turns black, but gradually becomes lighter, and at the end of fifteen minutes the process is finished. After half an hour's rest the clear oil is drawn off and heated, together with a little water to wash out the foreign matters; cover and settle and draw off the oil for use. Sometimes less and sometimes more of the chemicals is required, while some prefer to use only hydrochloric acid and leave out the sulphuric acid. Instead of bi-chromate of potash there may also be used the bi-chromate of soda, which is cheaper and soluble in warm water. As all strong chemicals affect the quality of the oils, it is always best to use the smallest amount of the bleaching agents that may be likely to do the work, and then, if not sufficiently bleached by the first operation, to repeat it once more with a smaller amount of chemicals. Whenever a sample taken of the oil that is undergoing the process of bleaching shows no improvement over a sample taken shortly before, then the operation is finished, so far as the amount of chemicals used is concerned.

PALMKERNEL OIL.

Peculiarities of palm kernel oil.

The kernel of the palm nut contains a large percentage of an oil, which is not, however, extracted in the countries where palm oil is made. But thousands of tons of the kernels are annually shipped to Europe and are there worked up for the oil, whence small amounts of it are also sent to this country. The oil is white and of an agreeable odor, but easily becomes rancid. In its effects and properties in soap making it occupies a position intermediate between tallow and cocoanut oil; like the latter it saponifies most readily with strong lye; the soap is capable of holding a large proportion of salts and water (although not so much as cocoanut oil); it is difficult to separate from the waste lye by salt; and the soap lathers similarly to that of cocoanut oil, which it also resembles in the manner of working in the kettle.

OLIVE OIL.

Great value of olive oil.

Although not used for soap making in this country to any considerable extent, olive oil deserves at least a brief mention in

these pages, since it is not only an eminently suitable material for soap, but has given to Castile soap that reputation from which it derives considerable credit even now, though much of the Castile soap of commerce at the present time is as innocent of any olive oil as is the cotton seed oil which is now so largely sold for the product of the olive.

Pure olive oil is pale yellow or greenish yellow, and contains, when cold pressed, about two-thirds olein, one-third palmitin and very little stearin. If pressed with the application of heat it will be richer in palmitin. Saponified, it forms a white or greenish soap, very mild and fatty, but lathering sparingly, especially in cold water, and becoming very hard with age.

This oil is used largely for soap making in Spain, France, Italy and other countries in southern Europe where the olive grows. In recent years olive growing has developed somewhat in California, but not sufficiently as yet to be of importance to our soap manufacturers.

OLIVE OIL FOOTS.

Definition of olive oil "foots."

By this name an oil is brought into commerce from Europe, and imported to some extent into this country, which is partly extracted from the residue left in pressing the olive, as well as from decayed olives, and partly consists of the dregs that deposit from the pressed oil on standing. To extract this oil from the residue, bisulphide of carbon is employed, in which the oil is soluble. The solvent named being very volatile, it is distilled off again, and a low grade of oil remains, which constitutes the bulk of the "foots." Olives that have been pressed cold once or twice for the best oil are also pressed a third time, together with water, and the resulting oil deposits a turbid sediment on standing which also goes into the foots, so that the product known by this name is of a somewhat indefinite character. It is, however, always characterized by a disagreeable odor, a dark green color, a thickly fluid consistency, the presence of more or less vegetable mucous and a larger proportion of palmitin than is contained in the olive oil.

Precaution required in their use.

It also frequently happens that quite appreciable amounts of the bisulphide of carbon are left in the foots, which renders care in their use necessary, for not only is the vapor of this substance exceedingly inflammable, but it has occurred that those engaged in using the foots for soap making have been overcome by the vapor given off on boiling or melting them.

The color of the olive oil foots and the impurities may be removed, to a great extent at least, by blowing steam into the oil through a perforated coil at the bottom of the vessel until the color gradually becomes quite light; during a few hours of subsequent rest a dark colored slime settles out, when some strong lye is sprinkled over it through a perforated pipe above the vessel and the oil allowed to settle again. Bleaching olive oil foots.

A more effective process of preparing the foots for soap making is as follows: Boil the foots on brine of about 12° B. until the dirty looking scum which at first rises, and which must be taken off, no longer appears. Let settle over night and draw off the clear oil from the sediment into a wooden vessel. Now mix for each 1,000 lbs. of oil 20 lbs. of peroxide of hydrogen with 3 lbs. of sal ammonia, and warm this mixture; then pour it in a fine stream into the oil, which must be continuously crutched while the bleaching liquid runs in and until brown streaks appear on the oil. Next the oil is at once washed with say 250 lbs. of boiling brine at 5° B. and left to settle again. The clear oil has then acquired a yellow color and will make good, common, light colored soap.

Unbleached foots yield a green soap, but this color sometimes changes to a dirty yellow, while at other times it remains, so that it is frequently supported by the addition of green coloring matter.

COTTON SEED OIL.

This oil has been familiar to the soap makers generally for the past 35 years only, as previous to that period the extent of the production of oil from cotton seed was very small.

The crude oil is a thickly fluid, dirty yellow to reddish oil of greatly varying quality, as the seeds from which it is obtained may be of good or of poor quality, according to the season; they may have been stored for a considerable length of time, perhaps even had become damp and begun to decay, and they may have been handled in the oil mill and expressed with different degrees of care. The lower grades of crude oil generally contain a higher percentage of free fatty acids and therefore present a greater loss in refining; they also yield a lower quality of refined oil. On standing for some time a slimy deposit separates from the crude oil. Crude cotton seed oil.

Owing to the coloring matter and other impurities contained in it, the crude oil is not well adapted for soap making, but requires Refined oil.

refining. This operation is generally carried out in special oil refineries which obtain the crude oil from the mills. The process of refining consists in warming the oil in large tanks, and adding under constant agitation, through a perforated pipe above the tank, about 2 per cent. of 30° lye. The quantity, nature and strength of the lye used—whether soda or potash, entirely caustic or partly carbonated—depends on the quality of the oil and the judgment or preference of the refiner. The fatty acids and the lye combine rapidly to form a crude, black, and dirty soap which envelops a large amount of coloring matter; these soap particles will settle and leave the oil above sweet and light in color. If then found necessary, more lye may be added to purify the oil still further. When the oil is sufficiently refined, it is either allowed to rest at once, or first boiled up with about 1 per cent. of salt previously dissolved in hot water, to assist clarification; the impurities which settle to the bottom consist of partly formed soap, coloring matter, mucilaginous slime, and water or waste lye. The clear, pale-colored oil is drawn off, and washed out with water, and constitutes the grade known in commerce as "summer yellow." The sediment is brought on the market as "soap stock" or "foots."

Summer yellow.

Foots.

The oil, when refined as above described, consists of palmitin and olein, the former largely separating out at a low temperature. When the oil is chilled, a more liquid portion (mostly olein) may be separated from it, which is very suitable for a salad oil and known as "winter yellow"; the more solid portion (mostly palmitin) is brought on the market as "cotton stearin." By the latter name there is also sold another product, namely the solid *fatty acids* from factories making glycerine from cotton seed oil. Unless this is borne in mind the term is apt to confuse.

Winter yellow.

Cotton stearin.

Properties of cotton seed oil for soap making.

Cotton seed oil, and especially the refined article, saponifies with difficulty, and only gradually by long continued boiling; but the process may be hastened by the addition of other fats or of some soap scraps. The resulting soap is of a white color while fresh, and rather soft, so that the oil is generally used together with fats that form a more solid soap. In order to make a firm bar soap from cotton seed oil alone it is therefore necessary to finish it so that the soap should contain but little water. When the soap grows older it turns yellow, acquires a somewhat disagreeable odor and, worst of all, certain varieties become covered with yellow blotches. This latter phenomenon seems to be due to an unsaponifiable substance (hydro-carbon) in the oil, which is not

removed by the process of refining, but remains and finds its way into the soap, and under favorable circumstances is brought to the surface by the "sweating" of the soap. Curiously enough, these spots do not appear in the "boiled-down" soap of cotton seed oil, nor in "cold-made" soap containing silicate of soda; but on the other hand they are very pronounced in white "settled" soap soon after the same has been made. In rosin soap they are less noticeable.

The commercial refined oil may be bleached if required, by the use of Fuller's earth, or by potassium bichromate and hydrochloric acid, both processes having been described in the preceding pages in connection with the subject of tallow and palm oil. Bleaching, however, does not prevent the before-mentioned yellow spots in the soap. **Bleached oil.**

COTTON SEED STEARIN.

As was said under cotton seed oil, there is separated from the latter at a low temperature a portion of the solid palmitin, and this is brought into commerce as "cotton seed stearin." It is white, of about the consistency of cocoanut oil, and is a suitable material for soap making, as it gives a firmer bar than cotton seed oil; but in all other respects it has the same properties.

By cotton stearin is also sometimes understood the fatty acids of the oil, separated in glycerine factories. This would be a good material for soap makers also, but for the fact that it saponifies so rapidly that unsaponified particles become enclosed in clots of thick soap, in consequence of which it is difficult to work properly. (For particulars in regard to the saponification of this material see under "Red Oil.")

COTTON SEED FOOTS. SOAP STOCK.

The yellowish to dark brown sediment separated in refining cotton seed oil consists of variable proportions of imperfectly formed soap, water, coloring matter and dirt. It comes on the market as "soap stock" or "foots," although the latter name, properly speaking, refers to the dregs naturally settling from the crude oil. When made from oil pressed from decorticated seed it can be made into a fair grade of soap, but oil from undecorticated seed is so charged with coloring matter that the soap stock produced by refining it is hardly amenable to bleaching. On saponifying it in the kettle it turns almost black, and the spent lye **Composition of foots.**

Manner of saponifying foots. is very dark. In order to make soap as light in color as can be effected without bleaching of the stock, the saponification of the foots must be so conducted as to wash out with the waste lye as much of the coloring matters as possible. For this purpose care is taken in the first change never to allow the soap to become quite neutral, but always to have an excess of alkaline strength in the kettle, whereby the coloring matters once absorbed by the lye will remain in the same and not be incorporated in the soap. The waste lye from a previous boil, even if quite dark, may be used to advantage when beginning the saponification, as the glycerine contained therein assists in dissolving and removing the coloring matters. The waste lye may be run into the kettle, and while adding the foots an excess of strength is all the time kept up by also running in more lye. When the stock is all saponified and the soap still has a small excess of strength, it is grained with strong salt solution, and after a short rest the dirty lye is drawn off as hot as possible. Now another change of lye may be given; or if rosin is to be used, the soap is first boiled with the lye required for the same—using some spent lye again if convenient—and then adding the rosin, either all or part of it only if 2 or 3 changes are to be made. An excess of strength is again kept up till the last, as before. When all is saponified "pitch" and use the nigre in the next batch.

When using this nigre it is first grained on salt water or with dry salt; then sufficient stock is added to almost—not quite—neutralize the strength. Now the waste lye is drawn off, and then the proceeding is repeated as before.

Bleaching soap. Another method of making a light-colored soap from this material consists in bleaching the soap formed by its saponification. This process is carried out by boiling the completely formed soap, having an excess of strength, on a solution of hypochlorite of soda of 15 to 20° B. (This solution may be prepared by turning free chlorine gas * into a cold caustic soda lye until the latter is saturated with it.) When the soap "opens" it is allowed to settle, the waste lye drawn off, and after the soap has been "closed" again by running in water, the above treatment is repeated, until the desired color is obtained. Care is necessary *always* to have an excess of strength in the kettle, as otherwise

* This gas, liquefied by pressure, may be bought in iron drums holding about 220 lbs. each. It may be used for bleaching oils and fat, by making an aqueous solution and agitating it, together with the stock, in a wooden vessel.

hydrochloric acid will form and damage the kettle. This process is not entirely satisfactory, but gives fairly good results.

Soap stock may be used alone, but is generally employed in combination with the cheaper grades of grease and tallow. A peculiar feature of this material is in the yield of soap it affords, which must be taken into consideration in calculating the cost. While all other kinds of stock, by reason of the alkali and water used, yield an increase of soap estimated roughly at about 50 %, soap stock which only contains from say 40 to 60 % of fatty acids furnishes only about its own weight of soap, as it already contains considerable alkali, besides the water and impurities which are lost. **Yield of soap from foots.**

LINSEED OIL.

Linseed oil consists of 10 % palmitin, 10 % olein and 80 % linolein. Like cotton seed oil, it requires to be thoroughly well boiled with lye in order to be completely saponified; if any unsaponified linseed oil should be left in the soap, yellow stains and a rank odor will develop in time; but there is no unsaponifiable matter in the the pure oil, at least none that causes yellow spots. **Action of linseed oil in soap.**

Linseed oil alone makes a rather soft soap, but a small percentage of it used together with other fat, such as tallow, furnishes a soap yielding an exceedingly fine lather. It is therefore used in this manner in some special brands of toilet soap. **Lathering qualities.**

In Europe it is very largely used for soft (potash) soaps.

Linseed oil may be bleached by sulphuric acid, by crutching into it 4 % of this acid (66° B.) previously diluted with one part of water to four parts of acid. After crutching for thirty minutes the oil gradually assumes a dark green color, and is then allowed to rest for half an hour. Boiling water is next sprinkled over the oil, without crutching. A few days' rest is then allowed, when the oil will be clear and ready to be drawn off for use. **Bleaching linseed oil.**

Another way of bleaching it, better adapted for soapmaking by the cold process, consists in treating it with lye and alum, in the same manner as described under Tallow Bleaching; a rather larger proportion of alum must be used in this case.

CASTOR OIL.

This oil consists of ricinolein, with a small percentage only of stearin and palmitin. It saponifies readily with strong lye, giving a hard, tough, white, transparent soap, remaining hard **Peculiarities of castor oil.**

even with a large percentage of water. It lathers very little, however, and is therefore used only with other fats, when it is for the object of giving transparency to a soap, or when use is made of the fact that, owing to its density, it gives to soap an even texture and fine gloss; especially in milled soap the use of a small proportion of castor oil is in many cases very advisable.

Several qualities. There are several qualities of this oil, expressed either hot or cold, which must be selected according to the soap to be made, the hot pressed oil being somewhat yellow and therefore better adapted for colored soap. A peculiarity of castor oil is that it is completely soluble in alcohol.

WOOL GREASE. LANOLIN.

Wool, in its raw state, contains a peculiar compound, consisting of about one-half of wool grease and nearly one-half of carbonate of potash; large quantities of commercial potash are annually derived from this source, in the course of washing the wool. The ordinary wool grease of commerce is used mostly for dressing leather, being hardly suitable for soap making, owing to the large percentage of unsaponifiable matter it contains, and its naturally unpleasant odor, which is still further increased by the remaining odor of the solvents (benzine, ether, etc.) used in its manufacture.

Lanolin and wool grease for superfatted soaps. A special purified wool grease, containing a large proportion of water and known as "lanolin," is manufactured in Germany and imported from there; it is greatly recommended for use in ointments and pomades. Soapmakers have also employed small proportions of it, together with other fats, but mostly in an experimental way only, and for the purpose of "superfatting" soaps.

An anhydrous wool grease is also on the market, specially adapted to be incorporated into soap by milling.

VARIOUS OTHER OILS AND FATS.

In the foregoing pages the oils and fats used more or less extensively for soap making in the United States have been described; there are also a number of other oils which, being used for the same purpose in foreign countries, are mostly of casual interest only in the United States. But we can not pass them by without at least mentioning them.

Neatsfoot Oil gives a fine, white, but rather soft soap.

Fish Oils, of various kinds, yield soaps of a disagreeable odor, and are only used in very common grades of soft soap.

Sesame Oil; the finer qualities of this oil are used for table oil, while the ordinary grades are used extensively for soap making in Europe. The cold-pressed oil forms a rather soft soap, but the solid part separated at a low temperature yields a firm bar.

Peanut Oil is used largely in Europe, and especially in France, for making soap. The first cold pressure of the peanut yields a fine table oil. Oil of the second pressure (with cold water) is used mostly for illuminating purposes. A third, warm, pressure yields the oil used for soap making. For this purpose the oil is not unlike cotton seed oil in its action and product, but the soap has no yellow stains.

Hempseed Oil is used in soft soap, to which it gives a green color.

Sunflower Seed Oil is used largely in Russia for hard and soft soaps.

Colza Oil. This oil is used to some extent in soft soap.

Fuller's Fat. The soap used in "fulling" textile fabrics constitutes such large amounts that in some places the fatty acids are recovered by treating the waste waters of the factories with mineral acids ; the latter acids combine with the alkalies to soluble compounds, while the insoluble fatty acids rise to the surface, mixed with more or less coloring matter, and may be collected, purified as far as possible, and used over again for lower grades of soap. (For the saponification of such materials see under Oleic Acid and Rosin).

Corn Oil. This oil is pressed from the germs that have been separated from the corn used in distilleries and glucose and starch factories. It is, or was, until a high duty was collected on it, exported from this country to Germany, to be employed in place of linseed oil for making a soft soap. It may also be used in place of linseed oil, in addition to other fats, in making toilet soaps, to which it imparts good lathering properties. At present only a small quantity of this oil is made, and used mostly for tanning purposes. Being a drying oil, it requires to be well saponified in order that the soap may not become rancid in a short time.

OLEIC ACID. (RED OIL).

When tallow is worked up for the manufacture of glycerine and stearic acid, for the use of candle makers, the oleic acid is brought into commerce separately, under the name of "red oil," and used quite largely in soap making. According as the fat has been decomposed by distillation, or by treating it with a current of steam, the oleic acid is known as "distilled," or as "saponified," or elaine red oil (the separation of a fat into glycerine and fatty acids being technically termed "saponification"). The name "red oil" is derived from the red color which the acid assumes, partly by age, and partly by its action on the iron parts of the machinery used in its manufacture. The distilled red oil comes over when grease is distilled; it is thinner than the saponified red oil and contaminated with by-products of the process. The saponified red oil is pressed out from the mixture of fatty acids, which results from splitting up a fat by means of steam currents, as just stated; it is the better material of the two varieties.

Saponified and distilled red oil.

Red oil is of a consistency approaching that of lard, and made into soap it furnishes a rather soft and very soluble product, for which reason it is in favor with the textile manufacturers, who require a soap that will dissolve completely and readily in water of a low temperature. For bar soap it is used mostly to make the "German Mottled" soap, for, being boiled down, this variety contains less water, and is consequently harder and less wasteful in use than an ordinary soap of the same stock.

Properties for soap making.

Being a fatty acid, it does not—like neutral fats—require caustic lye to form soap, but will combine directly with carbonate of soda, driving the carbonic acid out of its combination with the alkali in doing so. In practice, however, caustic soda is preferable, as the carbonic acid eliminated from the carbonated lye would make the soap frothy and spongy.

Red oil may be saponified with carbonated alkali.

But since fatty acids combine almost instantly with alkali, the order of procedure in the case of red oil is reversed when saponifying, *i. e.*, the lye is first run into the kettle and then the fatty acid is gradually added. If it were done in the usual way of running the lye into the melted stock, the soap would "bunch" (form in lumps, in which would be enclosed particles of the red oil) so that the lye would be unable to act properly on the stock; the soap would then form imperfectly and be very difficult to handle in the kettle. It is, however, an advantage to use lye containing some carbonate of soda, or even salt, which makes the soap more liquid and more

Precautions in saponifying red oil.

mobile during the boiling. On the other hand, red oil may be employed to advantage for utilizing the carbonate of soda which is contained in the waste lyes, resulting from saponifying neutral fats with lye made of the lower grades of caustic. In saponifying red oil strong lye of 25° B., or over, is used; weak lyes are apt to cause frothing of the soap in the kettle.

Red oil for utilizing carbonate in lye.

The use of rosin together with red oil improves also the odor of the resulting soap (and the same is true regarding palm oil). One part of palm oil and two parts of red oil will yield a firm soap of much more agreeable odor than red oil alone. In course of time all soaps containing red oil become darker in color than they were when fresh.

ROSIN.

Rosin not unlike red oil in composition.

Rosin is in some respects not unlike oleic acid, especially in that it is saponifiable with carbonate of soda, for rosin is a mixture of several acids (sylvic and pinic acid &c., See App. Note 12,) and—as said under red oil,—these do not absolutely require the use of caustic soda, although the latter is for several reasons preferable to the carbonate in practice, as already stated. Soap made with rosin, and especially with that of the darker grades, becomes darker with age, while soap made from unbleached palm oil retains its yellow color when rosin has been used with it, although without the addition of rosin the color of such soap would soon fade on exposure to the air and light. Rosin alone cannot be made into a solid soap, and it softens every soap made of oils or fats into which it enters, and renders the same more easily soluble, so that it is best to use it in connection with fats rich in stearin which has a contrary effect. For this reason the rosin soaps are so popular in this country, as they are serviceable even when well dried, whereas a soap made of tallow alone, for instance, would become hard and practically insoluble. While fresh they wash more rapidly than any other soap, and will clean clothes which tallow soap fails to clean. All rosin soaps, however, have this disadvantage, that with age they become sticky, especially if the proportion of rosin used is large, although they do not become rancid, as some other soaps do. For use in hard, or in cold water, rosin soaps are most serviceable, being second only to cocoanut oil soap in this respect.

Rosin supports the color of palm oil soap.

Rosin is best used with fats rich in stearin.

Advantages of soap containing rosin.

For saponifying rosin, lye of about 20° B. may generally be used to advantage, as weak lye causes it to froth; but it will enter into combination with weak as well as with strong lye.

Rosin soap in waste lye. Being slightly soluble in salt water, more or less of the rosin soap is contained in the hot waste lye after saponifying the rosin and graining the soap with salt. On standing for some time to cool off this waste lye throws out of solution quite an appreciable amount of soap, which may be regained in this manner.

The color of rosin varies from a light yellow to a very dark brown and almost black, and this naturally affects the color of the soap made from it. By using some carbonate of soda with the lye employed for saponifying the rosin, a soap of lighter color will be obtained than when a very caustic lye is employed.

Bleaching rosin. For special purposes rosin may also be bleached by melting it, to let the dirt settle, and boiling the clear rosin once or twice on salt solution of 10°B. for an hour or so, running away the dark colored brine; 20 pounds of salt solution are used for 100 pounds of rosin.

Rosin not an adulteration. The employment of rosin has frequently been referred to as an adulteration of soap, even by soap makers themselves. This certainly is not justified by any means, as a consideration of the facts in the matter will readily show. First of all, the yellow rosin soaps are so very extensively made simply because the demand for them is greater than for any other kind of soap for laundry and general household purposes; this in itself would seem to demonstrate that rosin confers some desirable properties on soap. Secondly, the fact that rosin is cheaper by the pound than fats and oils does not of itself make it an adulteration, so long as it is used in proportions suitable for the purpose. Thirdly, as rosin consists of acids that are capable of forming a soap, its use can no more be considered an adulteration than the use of red oil, or cheap grease would be. Rosin can therefore be considered as an adulteration only when the soap is supposed to be made of high priced fats alone, and a corresponding price is paid therefor. Certainly no soap, other things being equal, will do washing at as low a cost and with as little effort as a soap will do which contains a moderate proportion of rosin. For use in cold water, or in hard water, rosin soap is in many respects unsurpassed.

In combining with lye, this material yields an amount of soap slightly below that gained from a like amount of fat; the exact gain cannot be given, as the commercial grades of rosin vary greatly.

CHAPTER III.

Lye.

Quality & strength of lye.

Lye is a solution of alkali in water, and may be of greatly varying composition, as regards strength *as well as quality.* The more alkali is dissolved in a given quantity of water, the heavier will of course become the lye, and for ordinary use the strength of a lye is therefore gauged directly by its weight. A very convenient instrument for the purpose of ascertaining the weight is a "hydrometer" or "alkalimeter" (see illustration), which is a glass tube, closed at both ends, and provided with a weight on one end and a graduated scale on the other; the latter serves to show how deep the instrument sinks into the lye, being so graduated that it indicates 0 in pure water, and higher numbers (degrees) as it sinks less deeply in the liquid, or in other words, as the lye becomes stronger. The graduation, as mostly used in this country, was designed by Baume, and the strength of alkaline and other solutions is therefore generally described as being "so many degrees Baume," meaning that the instrument described sinks to that degree of its scale into the lye. In England a different graduation, namely that of Twaddle, is more generally in use.

Fig 3.

Strength alone is no real indication of the character of lye.

In order to form a correct idea of the real strength of any lye it is, however, necessary to also consider the nature or *quality of the alkali* of which the lye was made, for the alkalies of commerce are brought into the market in several grades, containing varying proportions of pure caustic alkali, and since they correspondingly contain varying proportions of carbonated alkali, salt, sulphate of soda, and other impurities, it follows that two lyes of the same weight may differ considerably in their nature as well as *actual strength,* even though the indications of the hydrometer be the same in both.

In order to be a little more explicit we must now consider the commercial varieties of caustic and carbonated soda.

Commercial grades of alkali.

Grades of Alkali: Caustic soda is brought on the market in grades named respectively 60, 70, 72, 76% etc., the highest and almost chemically pure commercial grade of caustic soda being the 77% grade. To understand these denominations it must be remembered that 100 lbs. of pure caustic soda are formed by the combination of 77½ lbs. of sodium oxide with 22½ lbs. of water, and as the percentage of sodium oxide in a sample is the number expressing the grade, it follows that chemically pure caustic would grade 77½%. It should also be remembered that this mode of indicating the grade is in use in England and in the United States, while in Germany the percentage of *sodium carbonate*, which would be equivalent to the oxide, is named as the grade; in France still another notation is used which it is not necessary to describe here in detail. (See App. Note 8). On a similar principle as in the case of caustic soda are also designated the grades of carbonate of soda (soda ash etc.) and the analogous compounds of potash.

Quality of Lyes : To illustrate more plainly the difference in lyes made of the various grades of caustic, let us look at the composition of the latter:

Composition of caustic of different grades.

There are contained in 100 lbs. of commercial caustic soda of

	60–62%	70–72%
(Pure) Caustic Soda, about...	73 lbs.	86 lbs.
Carbonate of Soda, about.....	3 lbs.	2½ lbs.
Ordinary Salt, about	18 lbs.	5 lbs.
Sulphate of Soda, about.....	5 lbs.	4 lbs.

And small quantities of other substances, such as sulphite and silicate of sodium, etc.

The composition as shown above is subject to slight variations, but at all events the table shows that a lye made of 60–62% caustic soda is of a very different character than one made of 70–72% caustic, even though both indicate the same strength on the hydrometer. This difference is of course still greater with soda of 76%, and is moreover of much greater practical importance to the soap maker than is at present realized in many instances.

Effect of foreign salts on the soap in the kettle.

Effect of Lyes of Different Quality : The ordinary salt, the sulphate and the carbonate of soda, etc., contained in the alkali, being unable to form a chemical combination with the neutral fat or oil, remain simply mechanically mixed with the particles of soap

formed during the process of soap making, (the carbonate of soda may combine, however, under favorable circumstances, with *free* fatty acids, if any are present), and the presence of this admixture has in the first place the effect of rendering the soap in the kettle more mobile and liquid. When fats are boiled with a very high grade of caustic soda, that is to say with soda containing but a very small proportion of foreign salts, the resulting soap will be comparatively tough and thick, more difficult to manage in the kettle, and of a more or less brittle grain when finished. The greater mobility of the fluid soap when boiling, if the lye used was made of medium or low grade caustic, is an advantage in promoting the contact of lye and fat. In the "cold process" of soap making, however, the reverse is true, for in consequence of the necessarily limited time allowed, and the imperfect and slow motion of the mass during the operation of mixing, the best cold-made soap naturally results when the highest grade of caustic lye is employed, so as to permit the thorough contact of lye and fat, without the interference of foreign inert matter. As rosin and red oil, unlike the neutral fats, combine with carbonate as well as with caustic soda, mobility while boiling these materials with lye is insured by either the addition of salt in the kettle, or by taking care that there always be a surplus of uncombined lye in the kettle, which then—until it combines—has a similar effect, as the carbonate has when neutral fats are being saponified. In boiling soap a medium grade (70–72%) of caustic is therefore most generally employed, although many prefer 60% caustic to the higher grades, for all ordinary purposes, as the foreign salts in this grade cause easier and freer working in the kettle; still others use the medium grades and add salt to the lye while boiling, to obtain the same result, a practice which is as strongly condemned by some soap makers as it is recommended by others. The lower grades are less economical in use, as will be explained below, and ordinarily have no particular advantage for soap making purposes over the medium grades. The carbonate of soda of spent lyes may be utilized by boiling some red oil or rosin or rancid fat, on the lye after all the caustic strength has been bound; unless this is done the carbonate will be lost in the waste lye that is run away.

The best grades required for the cold process.

Lye for saponifying red oil and rosin.

Grades of caustic commonly used.

Saving the carbonate.

The various salts contained in commercial caustic soda, which are incapable of combining with fat, furthermore have this property that on dissolving in water they render the latter more and more incapable of holding soap in solution, so that soap may

be separated from its solution in water by adding enough salt, carbonate of soda, or even an excess of strong caustic lye, to the contents of the kettle.

Effect of foreign salts on the soap in the frames.

The presence of moderate quantities of foreign salts in the soap is of advantage not only while boiling, but is absolutely required—for mottled soaps—when the finished soap is run into the frames to mottle while cooling; the mottle is formed by the stearic acid soap crystallizing out of its solution in the oleic acid soap, and without the presence of foreign salts in proper proportions the soap would not possess sufficient mobility to allow of proper crystallization; the mottle would be a failure. Too much of the foreign salts, on the other hand, gives rise to certain disturbances (especially in soaps not containing cocoanut oil), depending partly on the diminished capacity of the soap to retain the water in its composition, and partly on the property of these salts to come to the surface of the cakes of soap while drying, and appearing there in minute white crystals, covering the soap with a white film. They also attract moisture from the atmosphere and cause the soap to "sweat" in consequence, in certain weather.

Excess of foreign salts.

In preparing lye, it is convenient and advantageous to use, when possible, the condensed water from the closed steam coil, as this water has been distilled and is consequently free from the lime and magnesia compounds whose presence gives rise to the formation of insoluble soaps, as explained in a previous chapter.

The composition of the lye being of considerable influence on the properties of the soap turned out, the following general observations will be found useful:

Different effect of foreign salts with different fats.

The several fats are not equally sensitive to the action of foreign salts in the lye; for instance, cocoanut oil soap—as has already been pointed out—is capable of holding a considerable quantity of salts and water without appearing the worse for it, particularly while still fresh; if a similar quantity of salt solutions were added to tallow soap, the latter would—if not separate entirely from the solution—certainly dry out very rapidly, become very hard and brittle, and covered with the crystals of the salt. In a general way, however, the following properties may be ascribed to the different salts and alkalies:

Pure Caustic Soda: Tends to cause a tough consistency of the soap in the kettle; a considerable excess (*i. e.*, too strong lye) drives the soap out of solution. The finished soap is hard, comparatively dry, and owing to its toughness, more likely to contain

particles of unsaponified fat, as well as to crack on drying, unless the saponification has been very carefully conducted. If present uncombined in the finished product, the soap will be very hard and unfit at least for the toilet.

Carbonate of Soda: Gives the soap greater mobility in the kettle, facilitates saponification if present in moderate quantity, and if in great excess, separates the soap from the lye. It combines with free fatty acids, but not with neutral fats. If present in the finished soap it inclines more than any other salt to come to the surface of the cakes when the water dries out. Still, a considerable quantity of the carbonate may be incorporated into a soap after boiling without this latter difficulty, managing so that the soda crystallizes *in* the soap, thereby hardening it and preventing the carbonate from coming to the surface; this will be more fully described in the chapter on "Settled Rosin Soap." Its presence has a less marked tendency to make the soap brittle than does common salt, and it is therefore sometimes employed together with the latter, in boiling down "mottled" soap.

Common Salt: This, more than any other salt, renders water incapable of dissolving soap and is therefore used largely as an addition after boiling, in order to separate the soap in the kettle from the waste lye. The salt dissolves in the waste lye, and with the exception of a very small amount, settles out again. Common salt also makes soap more brittle by its presence than does any other salt. It is for this reason that some soapmakers prefer to use some carbonate of soda in the salt pickle for boiling down mottled soap. It is sometimes found among the crystals formed on the surface of some soap, and indeed soap containing common salt inclines to effloresce. In settled rosin soap especially the presence of appreciable quantities of salt is disturbing, and when such soap is filled with sal soda and perhaps silicate of soda also, cracking and "whitewashing" are very apt to be the result. For this reason some manufacturers prefer to use strong lye, instead of salt, for separating soap from the waste lye, as traces of salt will always remain.

Potash: The potash compounds act similarly to the analogous soda combinations, but in every respect more mildly. Thus common salt (chloride of sodium) precipitates soap from its solutions, and renders it brittle, much more energetically than does chloride of potassium. Soap containing potassium salts is softer in consistency, more easily soluble in water, milder in its effects,

dries out less, effloresces less easily, and is of a tougher texture than that containing only soda salts. In fact, the substitution of potash in any hard soap for a part of the soda is an improvement, and would probably be a universal practice but for the higher price of potash compounds. But in calculating the comparative value of potash and soda for soap making, it should be remembered that considerable more potash than soda is required to saponify a given amount of fat; consequently the higher cost of potash is at least partly compensated for by the higher yield of soap caused by the presence of the increased amount of alkali. A quantity of fat requiring 40 lbs. of soda to form neutral soap will absorb 56 lbs. of potash for the same purpose, and will thus furnish 16 lbs. more of soap (the proportion of water present being considered the same in both cases). Soap made entirely with potash is known as "soft soap." A potash soap, however, if separated from the waste lye by means of common salt (chloride of sodium), will undergo a remarkable change: it will become a soda soap, and the waste lye will contain chloride of potassium, instead of the chloride of sodium. This chemical reaction is only a partial one though, and a soap made in this manner still contains considerable potash soap. At the time when wood ashes were almost universally used for soap making, the hard soaps were manufactured in just this manner, and a better grade of soap it would be hard to make, owing to the improvement made in the grain, texture, etc., by the potash still present. (App., Note 11.) A similar result is now sometimes obtained by using potash and soda lye together in saponifying fats, or—a less recommendable practice—by adding a carbonate of potash solution to a finished soap. (App., Note 11.)

Substitution of potash for soda.

More potash required for saponifying a given weight of fat than soda.

Peculiar effect of salt on potash soap.

The Effect of Lye of Different Strengths: As was said in the foregoing chapter, fats do not all require the same strength of lye to combine easily, but they all agree in readily taking stronger lye as saponification proceeds, than they will combine with at first. Thus tallow combines most easily at first with lye of not much over 10° B. in strength, if made of low grade caustic; but when saponification has once been induced, the strength of the lye can be rapidly increased up to 20° B. and over. Cocoanut oil combines most readily with strong lye. The stronger the lye used, the less water is unnecessarily introduced in the kettle, and the more easily is the soap managed. Too weak lye, in other words too much water, is also apt to induce frothing, more especially with the use of open steam for boiling, which adds the condensing

Proper strength of lye partly depends on the mode of applying steam.

water to the boiling mass. With closed steam alone weaker lye must be used, of course, than when open steam is used also.

Cost of Lye: Apart from their greater serviceableness for most purposes, the medium grades of caustic soda are also preferable on account of greater economy. The low grades are higher in price than the medium, because of the cost of freight, packages and other expenses on the foreign salts contained in the former, which after all are lost in the spent lye. The higher grades are more expensive because of greater difficulties in their manufacture. The cheapest way to buy caustic alkaline strength is undoubtedly by obtaining caustic soda of about 70–72% ; or the manufacturer may buy soda ash to advantage and causticize it himself, as described under "Lye Tank" in Chapter V.

CHAPTER IV.

Filling Materials.

A number of substances are frequently introduced into soap for certain special purposes, among which those intended primarily for cheapening or "filling" deserve separate mention.

Pure soap not always the most salable.

It may not appear right to add any such materials to soap, at least when the object is simply "adulteration," but on the other hand it is a fact that many manufacturers have failed in their attempts to create a demand for their brands of pure soap, which were specially made with the object to improve their product, and owing to the demands for *cheap* soaps they are—much against their own wishes—finding better sales for their "filled" soaps than for the pure goods. Having once been introduced, the manufacture of this class of goods is no longer a matter of choice on the part of the soap maker.

Talc, also known as Soapstone, French Chalk, or Steatite. This is a silicate of magnesia (about 60 per cent silica and 30 per cent magnesia), with iron and other impurities. It is added to some soaps to the extent of forty per cent (that is to say, 40 lbs. to 100 lbs. of pure soap), but smaller quantities are generally used. It has no value for cleansing purposes and is added principally to make weight; however, in small proportion it has at least the advantage of making the soap mild and agreeable to the skin; by absorbing water it solidifies the soap, causing the latter to preserve its appearance better on drying. It has the disadvantage however, of causing white soap to turn grayish on drying, while colored soaps are less brilliant and clear when filled with talc. It is for this reason frequently used in combination with silicate of soda. For cold-made soaps the talc is generally sifted into the melted fat, or first well mixed with a part of the fat and then stirred into

the bulk. To improve the texture of such soap it may be found to be of advantage to stir the talc into an equal weight of 2° lye and add this (when cooled sufficiently) to the soap when the last lye has been added.

Silex, or Silica. This is a mineral which constitutes quartz and most varieties of sand; it is used for filling soap in the form of a very fine white powder. Silex has no detergent properties, is insoluble in water, and gives the soap—besides weight—a surface which feels somewhat rough. In applying it, it is simply stirred into the soap, mixed with water.

Silicate of Soda, also Water Glass, or Soluble Glass. This is a compound of silicic acid and soda, and is made by fusing together sand and alkali. It is in the market in the form of a dry powder, but more ordinarily as a thick, syrupy solution. Its use is greatly to be preferred to silex, for silicate of soda has some detergent property of its own, owing to the alkali in its composition; besides it renders some hard water softer, thereby avoiding waste of soap. Silicate of soda is made in several forms and of various degrees of concentration (measured by the hydrometer) and may be easily diluted with water. It is generally used at a strength of about 40°B., but varies somewhat in composition, containing more or less alkali in excess. If weak in alkali it is sometimes necessary to add a pound of 38° lye for every 5 lbs. of silicate used in the soap, in order to prevent the silicic acid from crystallizing out. Fresh soap filled with silicate has a better appearance than one filled with talc, but on drying it becomes harder, lathers less, and is sharper on the skin. Cold-made soaps containing silicate are apt to have soft, spongy parts or even free fat collect in the center if run into large frames, especially so if an excess of lye is not used, or when the proportion of silicate added is small; such soaps are therefore best run into small frames. Silicate of soda is frequently used together with talc.

Silicate of potash is a similar article, and sometimes employed for filling soft soaps.

Varieties of silicate.

The form of silicate of soda most commonly employed by soap makers is known as "N" silicate, which has a strength of 39—40° B. and is sold ready to be used just as it comes from the barrel. For cold-made and half-boiled soap almost any desired amount may be added, from 30 to 50 lbs. to 100 lbs. of fat being a common proportion. In settled rosin soaps from 5 to 10 per cent. of the weight of soap is most generally used, together with a like amount

of carbonate of soda solution. "K" silicate is a similar preparation, somewhat milder and thinner than the "N" (36° B.) and also ready for use as it comes. "S" silicate is an old fashioned form, of the consistency of a jelly, but chemically similar to the grade "K." It requires melting by open steam and is but little used by the soap makers at present.

Starch is sometimes used in soap, but more for the purpose of binding the materials together than as an adulteration. By stirring starch into, say, like proportions of sal soda solution and silicate of soda, and boiling on open steam (in a closely covered kettle, to prevent it from jumping out) a thick mass is obtained which may be used in almost any proportion desired. By boiling in this manner, the starch absorbs much water and the filling is in every way more desirable than if the starch were used without having been boiled previously. Starch and flour, however, have this disadvantage that in the course of time, say a few months, they undergo decomposition, giving rise to a bad odor, and in severe cases even to fungoid growths on the surface of the soap.

Preparing starch for filling.

Mineral Soap Stock, a by-product obtained in petroleum refining, is used to a considerable extent in filling soaps. It is insoluble in water and has no detergent properties. Being a mineral product, it cannot be saponified.

Soda Ash, Sal Soda (Washing Soda) is not, strictly speaking, a mere cheapening ingredient, for it hardens the soap in which it is introduced, contributing to economy in its use and adding to its cleansing power. The use of this material is fully described in Chapter VII. For laundry soap this is undoubtedly the best filling material known, so far as the quality of the product is concerned. In washing with hard water the sal soda is quicker to act on the lime salts contained therein; it neutralizes them, and thereby saves much soap from being decomposed and wasted.

Sal soda not an adulteration.

Sulphate of Soda (Glauber's Salt) has a similar effect as sal soda on the hardness of the soap, but it is different in that it has no washing power, does not neutralize the salts of hard water, and that it is less liable to effloresce.

Common Salt hardens soap made largely of cocoanut oil and containing much water. It is not used very much as a filling in this country, however, but is quite common in cheap grades of cocoanut oil soaps made in Europe.

Carbonate of Potash (Pearl Ash) dissolved in water is used in some soaps as a filling material, softening the soap, improving its

texture and lathering property, and making it somewhat transparent. (Its tendency to soften the soap may be counteracted by the additional use of *salt water*, which is also used as a filling in some soaps containing much cocoanut oil.) It absorbs moisture, however, from the atmosphere in damp weather and spoils the wrappers thereby.

Borax is a useful addition, especially in laundry soaps, as it renders fabrics very white without affecting their fibres or delicate colors. It is a white, mildly alkaline mineral, which renders the soap more effective without attacking the skin in washing.

* * * * *

The above-mentioned substances are those most ordinarily used, either for filling or for increasing the detergent power of soap. To this list may be further added: *Sugar*, *Glycerine*, and *Alcohol* for transparent soaps; *Vaseline* (also Glycerine), and *Wax*, for emolliency; *Sand*, *Pumice Stone*, *Tripoli*, etc., for scouring soaps; *Sulphur*, *Tar*, etc., for medicated soap; *Ammonia*, *Oxgall*, *Benzin*, etc., for removing spots from cloths; and a long list of substances, such as *china clay*, *flour*, *dextrine*, *bran*, *oatmeal*, etc., which are added either as a simple adulteration, or for their (mostly imaginary) beneficial effect in certain cases.

CHAPTER V.

The Soap Factory.

The conditions determining the internal arrangements of a soap factory are so variable, that it is very little to the purpose, practically, to attempt the description of any one well arranged establishment of this kind. The quantities and varieties of soap turned out, the raw materials used, and the machinery available for the purpose, as well as the facilities of the building in which the factory is located, all have their peculiar bearing on the proper arrangement and equipment of the works. However, the avoidance of all unnecessary work being demanded alike by convenience and economy, a good rule which has been found to apply under almost all circumstances, is to elevate the raw materials to the upper floors of the factory, so that in the successive stages of manufacture they may descend by means of their own gravity to the lowest floor, whence the soap proceeds in the course of cutting, drying, pressing and packing, to the last (shipping) room of the factory, thus obviating as far as possible all pumping or repeated lifting on the elevator. In buildings occupying only little ground, so that there is not room on the lower floor for the operations of cutting, etc., mentioned, the frames of soap are generally brought to a higher story by the elevator and there cut, pressed and packed, and brought into the shipping room by means of the elevator or a chute. In large factories it is moreover found to be most economical to have separate engines in the several parts of the building where steam power is used, to obviate the use of much shafting and belting.

General rules governing arrangement of factory.

Further than this there is probably no general suggestion regarding arrangement that can be made, which will hold good in all cases. We will therefore proceed to a description of the

machinery placed in the factory, leaving the arrangement to the judgment of the practical soapmaker, who will suit his particular circumstances. The first appliance that is required is

THE LYE TANK.

The size and number of lye tanks used must be adapted, of course, to the requirements of the factory, as is also the manner of making the lye. The tanks are generally made cylindrical, and sometimes rectangular, of about ¼ inch sheet iron, and in most cases have a discharge pipe near the bottom, through which the lye runs off by its own gravity when the discharge cock is opened; this pipe is best arranged with a slight upward inclination, so that dirt cannot too easily run out. A steam pipe is also provided to introduce steam for heating, to dissolve the alkali, or when it is found desirable to accelerate the solution of the caustic in the

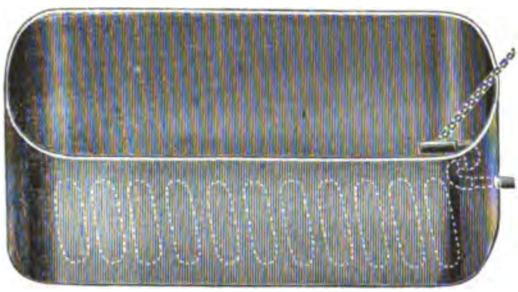


Fig. 4.

water, although with proper manipulation this aid is not really required, except to save time when in a hurry, or when poor grades of alkali are to be dissolved; ordinarily—with good grades of caustic—the heat which is developed spontaneously by the process of dissolving the caustic is sufficient, if rightly managed. The tank should be large enough in diameter to admit one or more drums of alkali when placed in it crosswise. Such simple tanks as described are most ordinarily used for making the lye, the caustic being simply placed on the bottom and sufficient water run in to make lye of the desired strength. In some factories the drums are pounded with heavy hammers, to break up the caustic which is then thrown into the tanks, to be dissolved with the aid of steam.

In some factories the iron drum is removed without breaking up the caustic, and the latter is placed in solid blocks on the bottom

of the tank as before mentioned; on running in water, if high-grade caustic is used, the latter dissolves without the aid of steam, and the lye near the bottom is very strong, becoming gradually weaker towards the top. By using a swing-joint pipe for drawing off the lye—similar to the pipe used for drawing the soap from the kettles —lye of different strength may be drawn from the same tank, by simply raising or lowering the inlet of this pipe. (See Figure 4.) Where smaller quantities of lye are made at one time the follow-following plan may be found very convenient:

The drum, after removing only the heads, is suspended above the lye tank by an overhead differential pulley block, (Moore's

Fig. 5.

patent and others), and lowered until it is just covered by the water contained in the tank. As fast as the lye forms it sinks to the bottom, forcing the fresh water up; the heat developed spontaneously aids in the solution, and as water or weak lye continues to be displaced by the stronger lye and to rise to the top, the caustic is soon dissolved. By making the lye in this manner, mechanical agitation, breaking up the caustic, and also the use of steam, are avoided, and the very little extra time required may be saved, if necessary, by using an extra tank at the same time, or

one large enough to admit a sufficient number of drums at a time. (See Fig. 5.)

Instead of suspending the drums by a chain, a false bottom or grate may be placed in the tank for the drums to rest on, or supports may be laid across the sides of the tank on which the caustic is rolled, after removing the iron drum. These supports may be connected

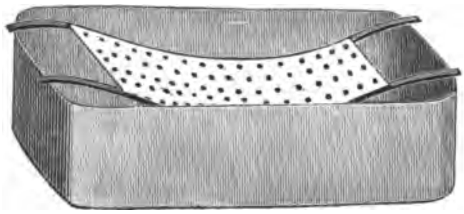


Fig. 6.

by perforated sheet iron to prevent large lumps of caustic falling in while melting. When this arrangement is used it is convenient to have the top of the tank even with the floor to facilitate rolling on the caustic. (See Fig. 6.)

This arrangement, although exceedingly convenient, is not used so much as it deserves to be; in most factories the caustic is broken up by pounding the drum, and placed on the bottom of the

Fig. 7.

tank; water is then run in, and open steam introduced to agitate and rapidly heat the mass.

Still another arrangement, which is not much used however, consists of an ordinary tank into which a smaller perforated cylinder, or a wire netting, has been set. The caustic is placed between the two cylinders and water admitted into the tank. A mechanical agitator which reaches into the water is then set in motion until all the caustic is dissolved. The object of the inner cylinder is to keep the lumps of caustic from interfering with the agitator blades. (See Fig. 7, page 78.)

Cooling lye rapidly, for cold process.

If the lye made is to be used for cold-process soap, it may at times be necessary to have some provision made for cooling it off rapidly, in order to save time. For this purpose a coil

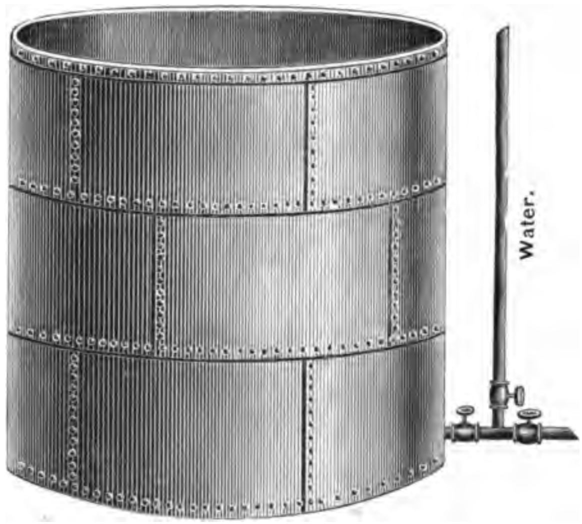


Fig. 8.

of pipe may be set into the tank, through which cold water may be circulated after all the caustic has been dissolved. When possible, however, it is much better to let the lye for cold made soap cool off slowly, so that the dirt settling to the bottom, and that rising in the form of a scum, may be separated from it before use.

Settling lye.

Means of preserving lye for cold process.

Lye for the cold process requiring to be very caustic, it is also necessary to prevent it from absorbing carbonic acid from the atmosphere; to this end different devices are adopted. Probably the simplest, and at the same time most effective method, is to place in the tank a quantity of mineral soap stock which will, as it does not saponify, always float on the surface of the lye and thus effectually exclude the air. Others cover the tank as nearly air

tight as possible, and perhaps place some quicklime on the top to absorb the carbonic acid from the surrounding atmosphere. This is objectionable, however, as it is rather inefficient, and there is always the danger of some of the lime falling accidentally into the lye.

Water connection with lye tank.

A convenient arrangement on a lye tank is also a water pipe connected with the discharge pipe, as in the engraving on page 79. Its object is to permit drawing off either water or lye, or both together, at pleasure, so that the pipe leading to the kettle will carry any desired strength of lye, from the strong lye in the tank down to simple water, according to how far the different valves are opened.

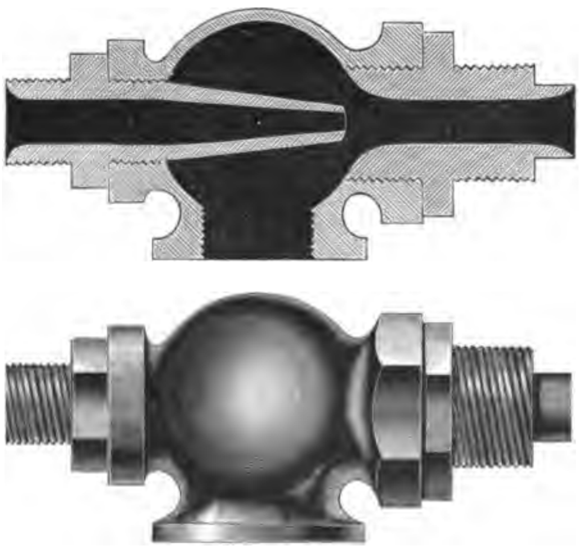


Fig. 9.

The lye pipe might be given a short upward bend on issuing from the tank, which will have a tendency to prevent foreign matters, which have settled to the bottom, from going out.

Although the lye tank should be placed higher than the kettle, so that the lye may run out of its own accord into the latter, circumstances at times require that the lye be raised to a higher level. For this purpose a steam-syphon is adapted, which works on the principle as herewith illustrated, and which by the injection of a current of steam through the tapering tube creates a vacuum that forces the lye to rise into the hollow globe and then forces it

upward through the outlet. Apparatus of this kind are made by A. W. Cadman & Co. and others.

STRUNZ' LYE APPARATUS.

The manufacture, in the soap factory, of caustic lye from soda ash, by means of lime, was the universal practice before caustic soda became an article of commerce; but the crude appliances

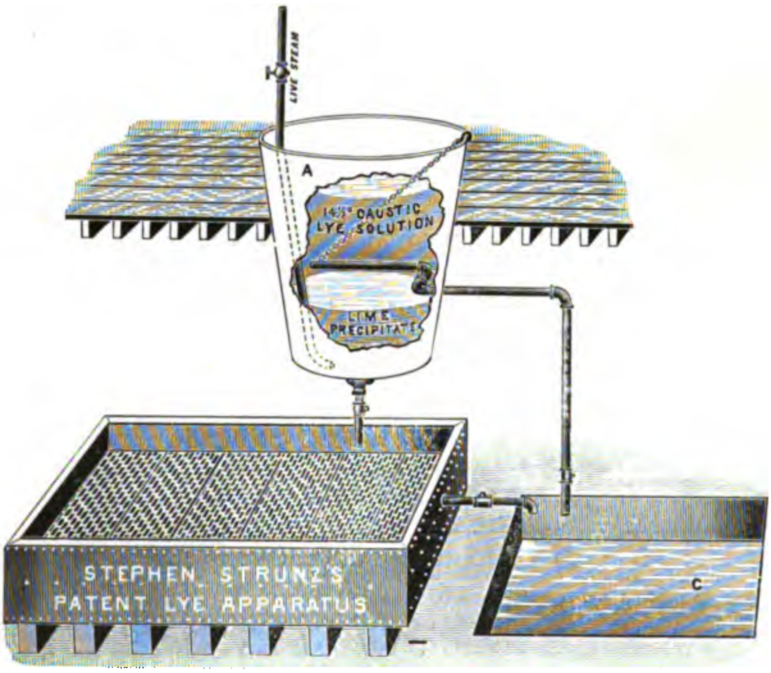


Fig. 10.

used for the purpose were so inconvenient, that in course of time commercial caustic soda came into general use in this country. In the meantime, however, improvements have also been made in the apparatus and methods by which soda ash is made caustic by the soap maker, and the apparatus here illustrated has been devised with a view to prepare lye more cheaply where it is made in large quantities. (See App., Note 13.)

Improvements in causticizing soda ash.

The process of causticizing a solution of soda ash, as used in former years, consisted in boiling a 20-25° B. soda ash solution with slaked lime, whereby the lime absorbed most of the carbonic acid of the soda ash, and was precipitated, leaving a more or less caustic lye above. The repeated washing and decanting necessary

to gain from the precipitate the remnants of lye mixed with it were very troublesome, and the greatest strength at which a perfectly caustic lye could be made was about 10°B. Any attempt to make stronger lye by this process would result in more or less carbonate being contained in it, as the lime can not act in a very concentrated solution. In the apparatus illustrated on page 81, made by F. B. Strunz, Pittsburg, Pa., the slaked lime is substituted by solid lumps of lime resting on a perforated diaphragm in the upper part of the kettle. As the lumps dissolve, the lime passes through the perforations into the soda ash solution, whereby a perfectly caustic lye of 14 ½° B. is made. (All the carbonated soda having been converted into caustic in this case, the lye *might* be made still heavier by the addition of some salt, in which case it would approach in quality a lye made by dissolving low or medium grades of caustic). The lye is drawn off through a pipe above the precipitate, and the latter is run upon the Lye Apparatus. This machine consists of a box containing filtering material placed between sheets of perforated iron. The lye still mixed with the precipitate is easily drained and washed out on this apparatus, whereupon the lime waste is shoveled into the sewer, whence a stream of water carries it away without trouble. The apparatus is twelve feet long, six feet wide, and 2½ feet high, and has a capacity equivalent to a solution of 600 to 800 ℔s. 77% commercial caustic per day. 800 ℔s. soda ash of 58%, and 650 ℔s. of good lime, furnish lye equal in quantity and quality to that made by dissolving 600 ℔s. 77% caustic.

Proportions of materials.

Testing lime.

The lime used should be well burned and be as free from contamination by magnesia as possible. If more than 80 ℔s. lime are required for 100 ℔s. of pure soda ash to make perfectly caustic lye, the lime is of an inferior quality. A trial batch is the best test for the purpose of ascertaining the purity of the lime. Besides being an impurity, the presence of magnesia retards the settling of the lime precipitate. When stronger lye is required than 14½°B. the product is evaporated by boiling, until of the required concentration; for this purpose waste steam from the coils of the soap kettles, &c., may be used.

Cost of lye.

Regarding the cost of lye made by this process as compared with that made by dissolving caustic soda, Mr. Strunz furnished in the *American Soap Journal* the following figures, which may be readily changed to suit different localities, etc.:

"In Pittsburgh the saving amounts to about 1⅓ cents per

pound, figuring Pure Alkali at \$1.42½ for 48 %; Caustic Soda 77 % at \$3.08 for 60 %, and freight on each at 15 cents per cwt. from New York. Lime is worth 20 cents per cwt., f. o. b. Pittsburgh.

600 lbs Caustic, 77 %, at \$3.08 for 60 %	\$23 72
Freight on 600 lbs Caustic from New York to Pittsburgh	90
Labor, dissolving Caustic	15
	\$24 77

"Caustic Lye Solution, equivalent to 600 lbs Caustic Soda of 76 %, is produced by:

800 lbs. Soda Ash, 58 %, \$1.42½ for 48 % (at \$1.72)	\$13 76	
Freight on 800 lbs. from New York to Pittsburg, at 15 cents per cwt	1 20	
650 lbs. Lime, 20 cents per cwt	1 30	
Labor, preparing soda ash solution and adding Lime, 1½ hours ... 23 cents		
Labor, removing lime waste from lye apparatus, 1 hour ... 15 cents	38	—\$16 64
Saving on 600 lbs. Caustic, 77 %		\$8 13
or, \$1.35½ per cwt.		

"In the East, where oyster shell lime can be procured at 13 cents per cwt., and on account of a slightly greater difference between the f. o. b. prices of Caustic and Soda Ash, the saving is somewhat more: Figuring \$1.48 per cwt. of 77 % Caustic, or very nearly 1½ cents per pound."

THE MELTING TROUGH.

In smaller factories the tallow and other stock are often simply dug out of the barrels and placed in the kettle to melt. This entails more or less damage to the packages and considerable work, for which reasons the melting of the stock by steam introduced into the barrels is much to be preferred. A trough is used for this purpose, upon which the barrels are placed, and which receives the melted stock; it is made of sheet-iron, rectangular in form, and need not be more than about five inches high. The barrels are placed across the trough, or on timbers laid across the end pieces of the latter, with their open bung-holes downward. Pipes of ½-inch diameter are so arranged that steam can be turned into the

barrels through the bungholes, either by having a separate pipe for each barrel, as shown in the accompanying engraving, or by a main pipe along the bottom of the trough, from which branches reach upward into the hogsheads or barrels, as indicated by the dotted lines in the same engraving just referred to. The ends of these branch pipes have an elbow joint, which turns easily, so that it may be introduced into the bunghole after the package has been properly placed.

By admitting steam through the pipes the contents of the hogsheads are quickly emptied and can be run to the kettle or settling tank while still hot, thus saving most of the heat expended

Fig. 11.

on the operation. A fine wire sieve should be placed in the trough where the discharge pipe is connected, so as to arrest chips of wood and dirt, that would otherwise go into the kettle.

Instead of a trough, a simple rack may be used to support the barrels for melting the stock.

THE SETTLING TANK.

From the melting apparatus the stock should be run to a settling tank, so that it may be properly settled and also examined, instead of running it directly into the kettle. This settling tank should be arranged with marks indicating its capacity, so that the amount of stock placed in it or withdrawn from it may always be approximately calculated.

THE STOCK BLOWER.

Unless the melting trough (or the settling tank) is so placed that the melted stock runs to the kettles by its own gravity, some provision for conveying it there is required. This may be done by a pump or by a blower. The pump will be described hereafter.

The stock blower, which is used in some factories for convey-

ing the fats from the settling tanks to the kettles, consists of a sheet-iron tank provided with a tight-fitting cover, and is tested for a pressure of at least 80 lbs. to the square inch. It has a 1½-inch

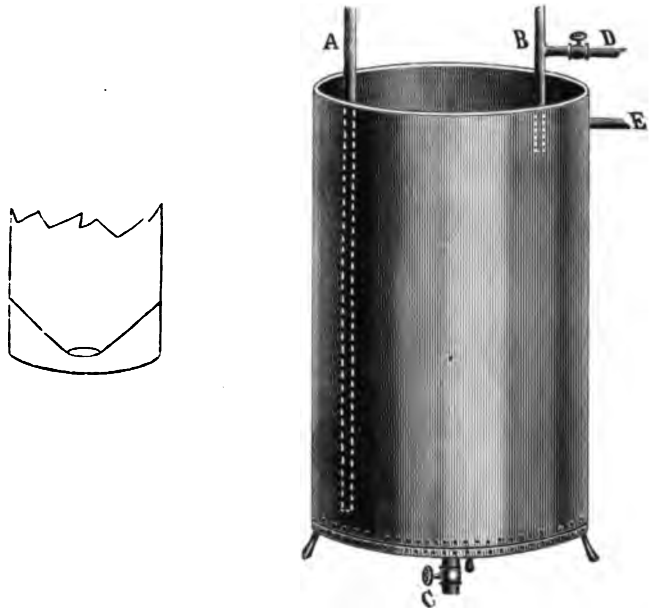


Fig. 12.

pipe (A) reaching nearly to the bottom of the tank, for carrying off the stock. B is a pipe for admitting steam, the pressure of which forces the stock out of the tank. D is a pipe through which the steam escapes from the empty blower when fresh stock runs in. E is a pipe from the stock tank. C is a valve through which accumulated dirt may be blown out. A steam pipe should also be connected with pipe A for blowing back, to clear it in case it becomes clogged by fat that may have become chilled. This apparatus may be improved for some uses by inserting a dished false bottom (see small engraving), with a hole in the centre. The dirt and water settling out from the stock (which may be kept warm by waste steam) would find its way below the false bottom and be prevented by the latter from going along with the stock on emptying the tank under pressure.

THE SOAP KETTLE.

In regard to soap kettles there are a great many variations, not alone in the actual requirements, but also in the opinions prevailing among practical soap boilers.

All kettles heated by steam.

In Europe the kettles or "pans" are still in many instances heated by fire, while the contents are stirred by hand, but this feature has been superseded in this country many years ago by the use of steam; it is therefore not necessary here to point out the many advantages which steam kettles have over the old-fashioned fire-heated affairs.

Size of kettles.

As to size, soap kettles range from a capacity of a few thousand pounds to those holding 150,000 lbs. of finished soap, and more; the largest kettles still practical to use hold not much over 250,000 lbs. In shape the cylindrical form is the most common, square kettles being comparatively rare as they are in several respects inconvenient to use. The walls of the kettles are either perpendicular or taper towards the bottom.

A kettle of the latter kind, and the connections required for practical working, are illustrated by the accompanying Fig. 14, which represents one of the kettles used in the factory of Messrs. A. MELZER & Co., of Evansville, Ind., as described by them in the *American Soap Journal*, as follows:

"The dimensions of this kettle are: Depth, 15 feet; diameter across top, 15 feet; diameter across bottom, 10 feet; capacity, 60,000 pounds Settled Soap. Bottom of kettle is made of ¼ inch flange iron dished 12 inches. The first 4 feet of sides of kettle are made of ¼ inch iron, the balance 3-16 inch; seams vertical.

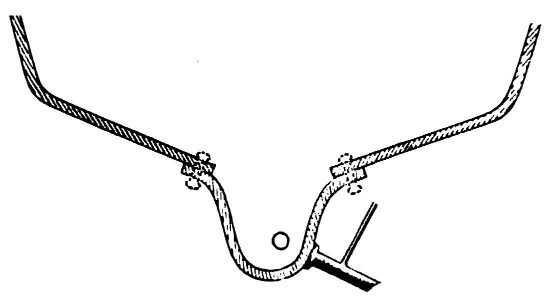
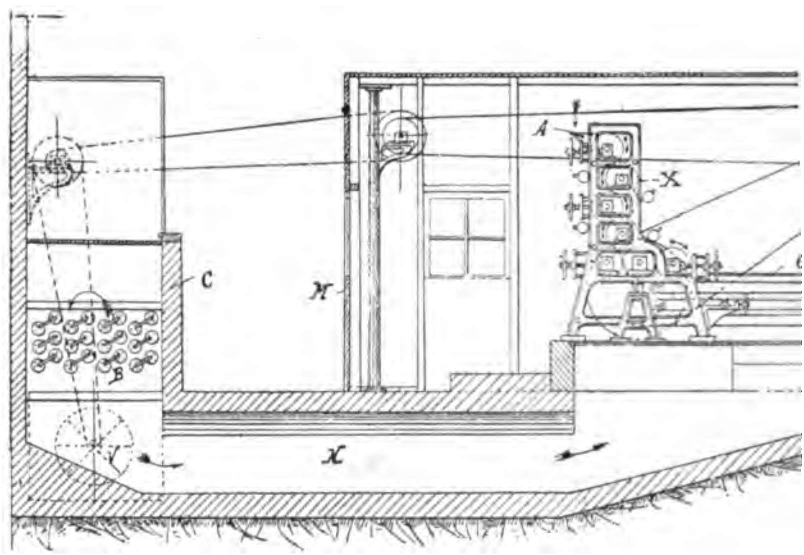
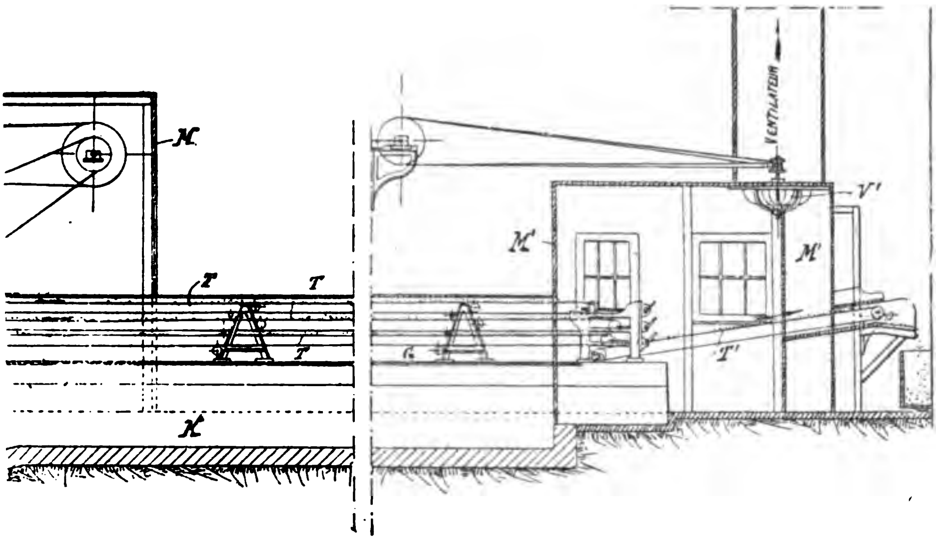


Fig. 13.

To center of bottom is riveted a heavy cast-iron pouch (Fig. 13), tapped for two 2½-inch pipes, one for running out the spent lye, and the other, which is at right angles to the first, for running out the



THE NEW FRENCH SYSTE



OF MILLING. (See Pages 133 and 134.)

nigre into a receptacle for that purpose, preparatory to pumping it into other kettles. This latter pipe may be connected direct with a rotary pump, but in this case there would be liability of sand and nails getting into the pump, which might cause much trouble. Both these discharge pipes are supplied with a half-inch steam pipe for clearing them of cold soap, sticks and other obstructions that may have lodged therein. The steam pipes that feed the coils in the kettles enter through cast-iron flanges and an extra 3/8 inch wrought plate riveted on side of the kettle just above the bottom. Each kettle is supplied with a general steam valve, which shuts off the steam on all the coils; a valve for each, the open and closed coils, and a small valve or pet cock for draining the pipes and to let escape freely any steam which may pass the main valve, and thus prevent any possibility of it getting into the kettle at a time when it is not wanted there. These valves can all be operated by means of iron rods conveniently located at the kettles in the boiling room. The pouch on bottom of the kettle is covered over by a grating made of 1/4 inch wire and having 3/4 inch meshes for the purpose of preventing bungs or tools that may have found their way into the kettle from obstructing the discharge pipes. The open steam coil is a single 36 inch ring, made of extra strong 1 1/4 inch pipe and perforated with a sufficient number of 1/8 inch holes. The closed steam coil is a flat spiral, containing 350 feet of continuous 1 1/4 inch extra strong pipe. This form of coils we have found the most practical, after trying a variety.

"The finished soap is discharged through a 3-inch pipe that enters the kettle just above the steam pipes. On inside of kettle this pipe is about 6 feet long and at the lower end is provided with two elbows which form a hinge, so that the pipe may be swung over and gradually lowered to a point just above the nigre. When soap is all out this pipe is drawn back to a vertical position by means of the chain attached to its top, and the mouth of pipe is closed with a cap attached to a 3/4 inch iron rod, with a "T" handle, that reaches to the top of the kettle.

Arrangement for preventing boiling over.

"Running across top of the kettle is a shaft, for which 1 1/2 inch extra strong pipe will answer, and mounted thereon is a reel or paddle wheel as shown in Fig. 15, page 88.

"The arms or spokes of this reel are made of 1/4 x 1 1/2 inch iron and are 16 inches long from center of shaft to end of the arms; the blades, four in number, are 1/8 x 4 x 24 inches, and we find this size reel amply sufficient to hold down the soap. In our

factory these reels are driven by a small special engine, which also drives the fans for keeping the air in motion in the Boiling Room ; they require little power, and the work performed by them as compared to the work of a paddle or shovel in the hands of a man,

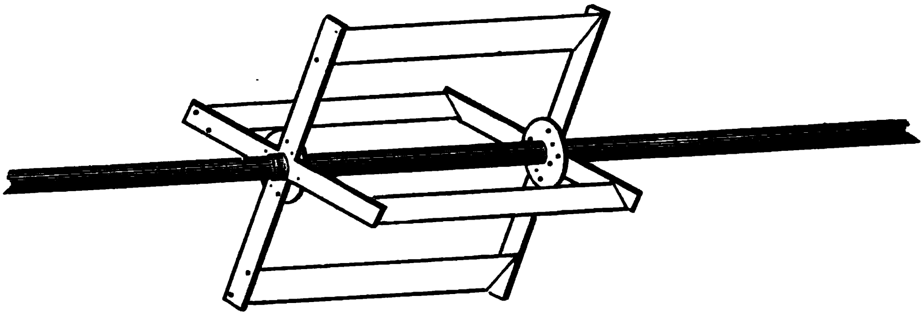


Fig. 15.

is like the work of a steamboat wheel and that of a boat oar. This apparatus has been in use in some factories of our country for many years.

"To prevent the soap from cooling too rapidly around the sides of the kettle, this is jacketed from the bottom to the floor above, with 2-inch wooden staves, and to prevent the heat and steam of the kettle from filling the Boiling Room to the discomfort of those employed therein, the kettle is encased from its top to the floor next above. On this floor the rosin is broken up and through a chute is conducted into the kettle. By this arrangement two men can easily do the work of four that have to shovel the rosin over the side of the kettle, and all rosin dust is kept out of the Boiling Room. From rosin floor to the roof and a few feet above, a suitable chute (ours are made of sheet iron and are 5 feet in diameter) carries the steam out of doors. This chute is provided with a cut-off or damper to prevent the cold air in winter from descending into the kettle when not a-boiling.

"The fats, lye, water or brine run into this kettle through a system of pipes under the control of the soap boiler or attendant, and the finished soap runs out through the 3-inch pipe mentioned above. The time required for framing a 50,000 to 60,000 lbs. batch is from three to four hours."

The next illustration (Fig. 16) is a sectional view of a kettle, arranged somewhat similarly, but having vertical walls, and the closed

steam pipe arranged "criss-cross" instead of spirally. This pipe is less expensive and for not too large kettles just as effective as a spiral coil; it covers the bottom of the kettle to within about a foot of the walls, the space left free being required for convenience in cleaning. For larger kettles this pipe has the disadvantage that the hottest steam is all on one side of the kettle, and the boiling there-

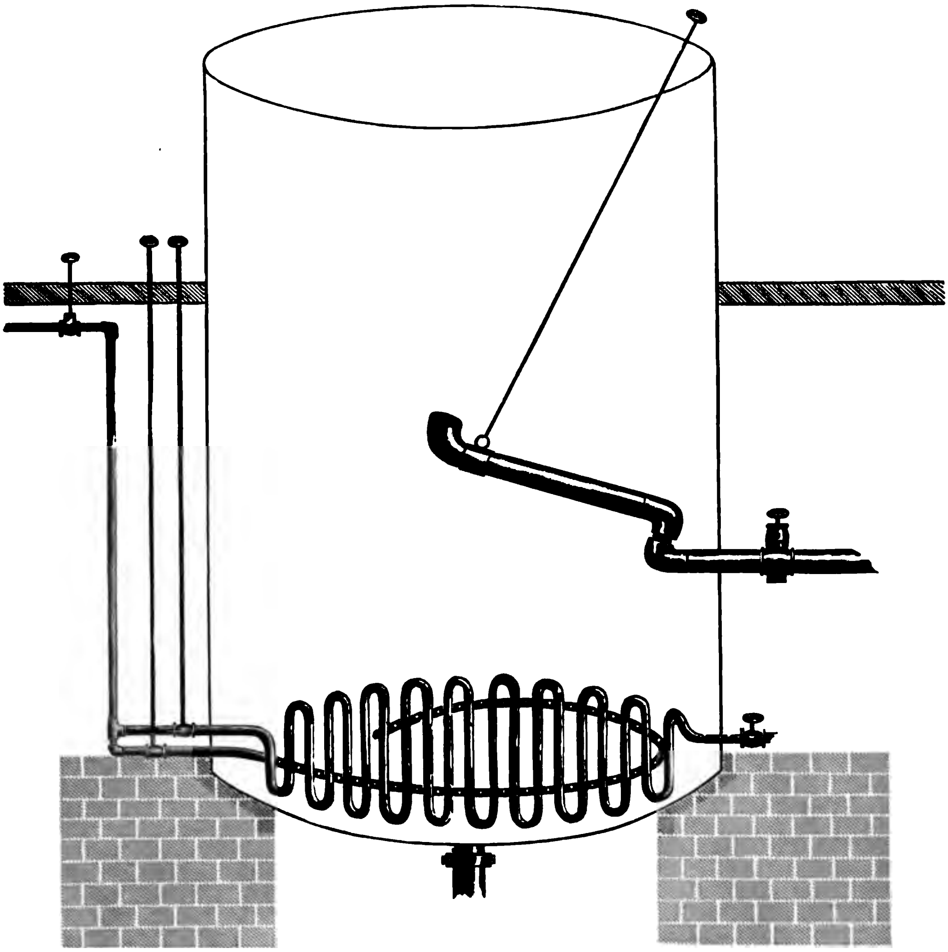


Fig. 16.

by apt to be uneven. The open steam coil has a diameter about ⅔ that of the bottom of the kettle; its perforations are similar as already described, their total area not to exceed the capacity of the pipe. The valves for opening and turning off the steam in the

pipes are placed (in both kettles shown) near the bottom of the kettles, so that on turning off the open steam the condensing steam in the pipe will not, by creating a partial vacuum, cause the soap to be forced up into the pipe and choke it on cooling. Both, the open and the closed pipe are 1 to 1¼ inch for a kettle of 60-80,000 lbs. capacity. The soap outlet pipe has already been described, and is shown in the last illustration as entering the kettle at a point above the "nigre" or dark soap. Its inlet is turned upward, which facilitates drawing off the soap from the nigre. Others prefer this opening turned downward, so that it can be used to draw the soap from an iron bucket sunk into the contents of the kettle, in such a manner that it may be conveniently employed to draw the last of the clean soap off from the "nigre" underneath, the soap being collected in the bucket and drawn off through the pipe. When not in use the inlet of the pipe is closed, as described before; a strainer may also be provided on the inlet, to prevent sticks or dirt from entering which might become lodged in the elbow joint of the pipe. Instead of the single valve shown on the outlet at the bottom of the kettle, two valves may be placed to advantage, one below the other as shown in the illustration below.

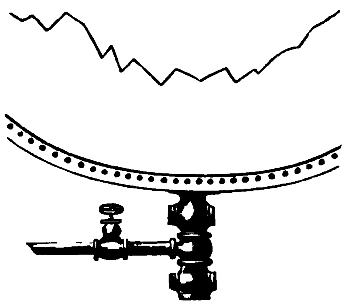


Fig. 17.

This arrangement not only provides against accident in case the single valve fails to close for any reason, but, by connecting a steam pipe between the two valves, any soap that may clog the lye outlet may be blown back; the kettle may even be temporarily heated by this steam connection, in case the open steam coil should have become clogged up by chilled soap.

Other forms of steam coils.

Some years ago a steam coil was adopted in many factories which, instead of over the bottom, was placed close to the walls of the kettle, running spirally along their inner surface for two or three feet in height. This form of coil was, however, soon

abandoned again in most factories, as the low coil near the bottom has the advantage of being mostly immersed in lye and thus keeping the soap from sticking to it; the high coil did not have this advantage, and, furthermore, the hot steam entering on the top cools off so much before reaching the bottom of the kettle, that in large kettles sometimes only the upper part of the contents, and that near the walls of the kettle, could be made to boil. The latter difficulty, however, could be at least partly avoided by running the steam pipe down almost to the bottom and then coiling it upward. In order to secure an even boiling throughout the kettle, the best plan is undoubtedly to have the closed coil placed flat over the bottom of the kettle. running it into the centre first—so that the hottest steam is in the middle—and then coiling it around to gradually approach the walls of the kettle, as shown in the next engraving.

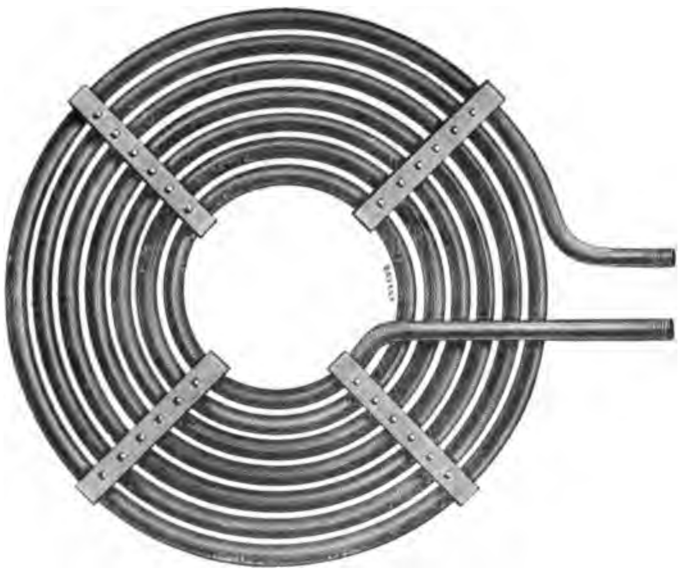


Fig. 18.

A convenient and effective combination of the several coils mentioned is illustrated by Figure 19, page 92, for which we are indebted to Messrs. James D. Cardell & Co., of Philadelphia.

Thirty years ago mechanical stirrers were frequently used to help stir the contents of the kettles. They have since been discontinued in nearly all cases, but at times they are quite con Mechanical stirrers.

venient to have, and may yet come into use again for the smaller kettles more than they are at present.

Open vs. closed steam.

In regard to the use of steam, it may also be mentioned that while both open and closed steam are found desirable by the great majority of manufacturers, there are those who advocate the use of

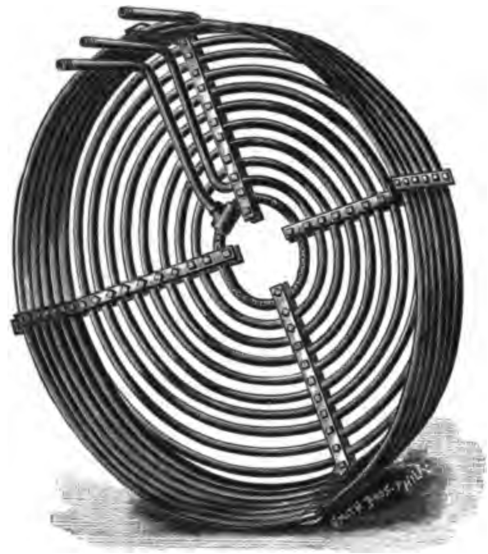


Fig. 19.

open steam only, and a few others who even believe that closed steam is all-sufficient, but these are matters which will probably never be settled to the satisfaction of all. The steam is used at a pressure of 3 to 4 atmospheres (one atmosphere = 15 lbs.). Superheated steam, as sometimes recommended, is hardly used. If much water is to be evaporated from a soap, a pressure of 5 atmospheres is quite sufficient.

Pressure of steam.

The steam, which has spent most of its heat while passing through the closed coil, is condensed into hot water on issuing from the coil, and can be used to advantage for various purposes, as for dissolving caustic, thus utilizing the heat it contains, and also taking advantage of the purity of the distilled water.

Jacketed kettles.

It still remains to mention the jacketed kettles, with double walls at the lower part, beween which steam circulates. This arrangement is not adapted for large kettles, nor indeed very practical in any ordinary case where a soap is to be boiled, as the dirt accumulating on the bottom prevents the heat from being properly

effective. When used, the bottom should not be rounded too much, but be flat and the jacket should not extend too far up, as otherwise the soap might boil in the upper part of the kettle only, and not at the bottom. If the fats are previously well clarified, for making fine toilet soaps, these kettles have the advantage that they can be cleaned more thoroughly, and that there are no steam pipes at the bottom between which undissolved salt or strong lye might remain in spite of all boiling; in this case also there is no danger of wasting heat by accumulated dirt at the bottom.

Dopp's Jacketed Toilet Soap Kettle: Within the cylinder *C* sus-

Fig. 20.

pended above the kettle (see Fig. 20) there runs a conveyor-screw *D* resembling the screw in some crutchers described further on, which is very effective for mixing or "crutching" the contents of the kettle. The agitator is easily taken apart for cleaning purposes, by simply loosening a set-screw, and may be raised and lowered at will, as well as swung out of the way when not in use.

For some purposes, notably in making half-boiled soaps, it is convenient to connect the steam pipe with a cold water pipe, in the manner shown in the accompanying drawing. This arrangement

permits of rapidly reducing the temperature of the contents, if this should be necessary to prevent boiling over, or when the stock to be used is too hot.

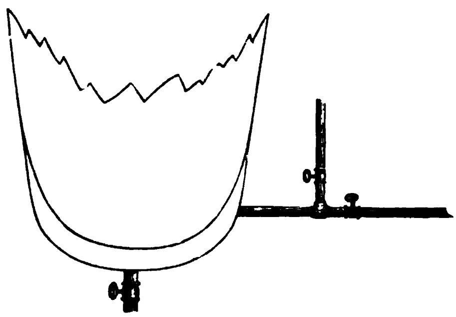


Fig. 21.

CONNECTIONS WITH KETTLES.

In the matter of facilities for charging and emptying the kettles, regard must of course be had to the peculiarities of the factory and the soap to be made. A soap pump being a practically indispensable machine around the factory, it is a good plan to connect the same with all the soap and lye outlet pipes, and to run the discharge pipes of the pump to all the other kettles and tanks used in connection with them. In this manner all possible contingencies for the disposal of the contents of the kettles are provided for.

THE SOAP PUMP.

Of the various pumps that have been constructed for the purposes of the soap factory, the HERSEY pump (Fig. 22, 23, 24) has come into general use and is looked upon by soap makers as the most suitable for this class of work.

Placing the pump.

This pump is set up in any convenient position, not more than ten feet above the bottom of the kettles, but preferably below the kettle, so that the soap flows into the pump by its own weight instead of requiring the pump to draw it upward. It is connected with the kettles, etc., as already described, and its discharge side should be connected with a steam pipe for occasional blowing back and cleaning. Valves are placed in the connecting pipes so that the pump can draw from and discharge into any of the kettles and tanks without disturbing the others. The special feature of this pump is that it conveys not only soap, but also hot as well as cold

oils, lye of every description, and water. With a speed of 120 revolutions per minute, the three sizes have a capacity of 3,000, 6,000 and 10,000 gallons per hour, respectively. The blade B swings on a pivot, and the cone-shaped piece D, by its contact with the cover, maintains a division between the two sides, so that in sweeping around the blade B, running in the direction of the arrow, draws the soap in at A and discharges it at C, emptying the pump twice in each revolution.

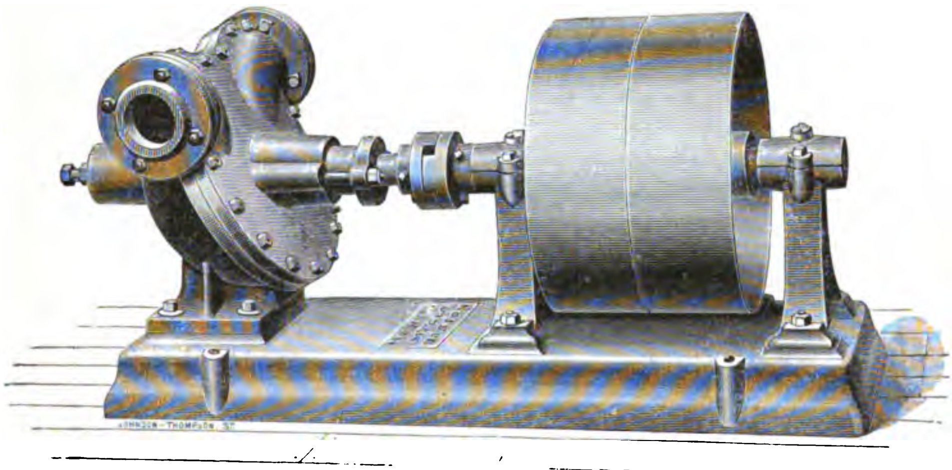


Fig. 22.

Fig. 23.

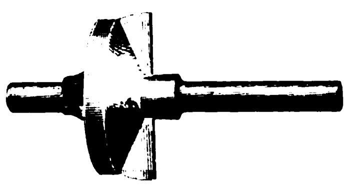


Fig. 24.

The opening marked A in the sectional view is the suction when the pump is run in the direction of the arrow; on reversing the machine the same opening becomes the discharge, and the opposite opening will then be the suction. The outlets are 2 to 3 inches in diameter, according to size of pump, and correspond to the size of the discharge pipes of the kettles as generally used. A

jacketed, and the legs (*B*) supporting it are made of gas pipe, through which steam may be admitted to the jacket. Open steam may also be turned directly into the soap by means of a single perforated coil near the bottom of the mixer. As the scraps of soap are carried upward by the screw they are thus heated by the open and closed steam until they become soft enough to be forced through the sieve placed above the cylinder. The sieve consists of two halves which are held in position by the arms *E*, and is readily removable.

The driving parts of the machine are so arranged that they can be quickly reversed, to facilitate emptying the crutcher.

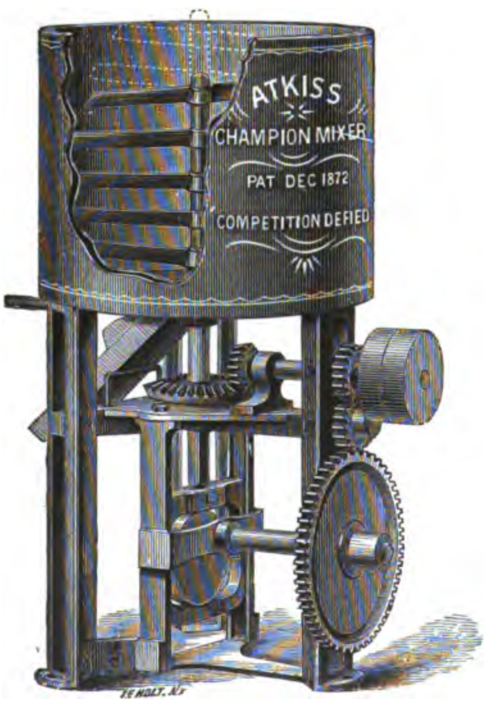


Fig. 26.

ATKISS' Mixer. The principle of mixing soap by this machine is evident by a glance at the illustration. The wings on the central shaft, as shown, have a slanting position, and in addition are raised and lowered as indicated by the dotted lines. (Fig. 26.)

STRUNZ' Crutcher. The interior view of this machine also explains itself. Soap is run in until the wings are completely

covered and the crutcher is set in motion in the direction required to work the soap toward the outlet, the central shaft making 50 revolutions per minute.

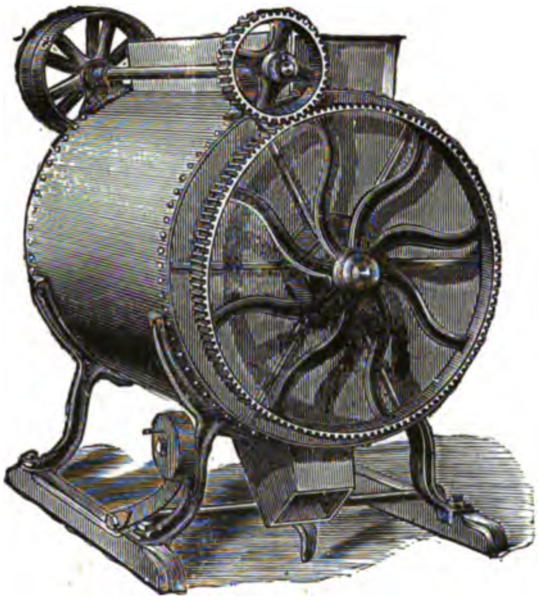


Fig. 27.—Outside View of Machine.

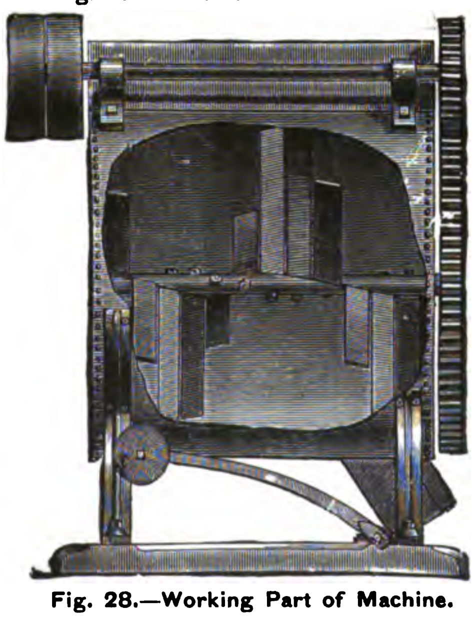


Fig. 28.—Working Part of Machine.

This style of crutcher is also made with a steam jacket, as shown in the next illustration. The direction of the steam or water, as the case may be, as it circulates through the machine,

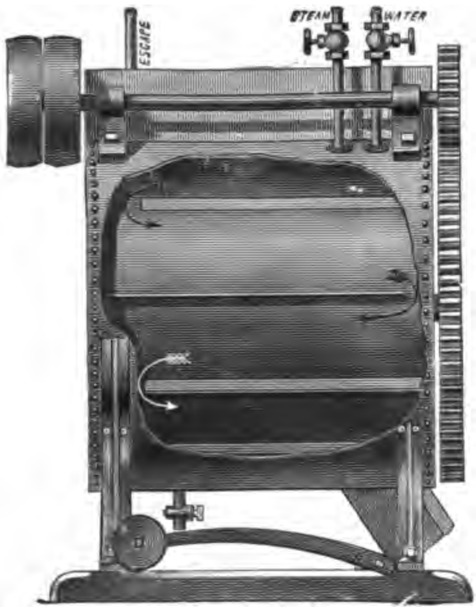


Fig. 29.
Jacket View of Machine.

is indicated by the arrows; also the pipe through which they escape. The valve at the bottom is for the purpose of drawing off the water left in the jacket at the end of the operation, which should never be overlooked, as its presence would cause a strain on admitting steam, or in cold weather even freezing and bursting of the jacket.

DOPP'S Crutcher and Remelter. This apparatus is made in two styles, that is to say, it is arranged either with or without a steam engine of its own. While, therefore, in the latter case the machine is driven by a special shaft and belt, the one with an engine of its own not only works independently from all other machines in the factory, but can be used in addition to transmit power (while the crutcher is either running or standing still) to run the elevator, or the soap pump, or such other machinery as may be in the factory.

This crutcher and remelter consists of a steam jacket and an inner shell, cast together in one piece, and having a large outlet in the center of the bottom for discharging the contents. In the center of the kettle is placed a steam heating radiator formed by a system of vertical pipes arranged cylindrically, and with open spaces between them ; steam passes through this radiator into the

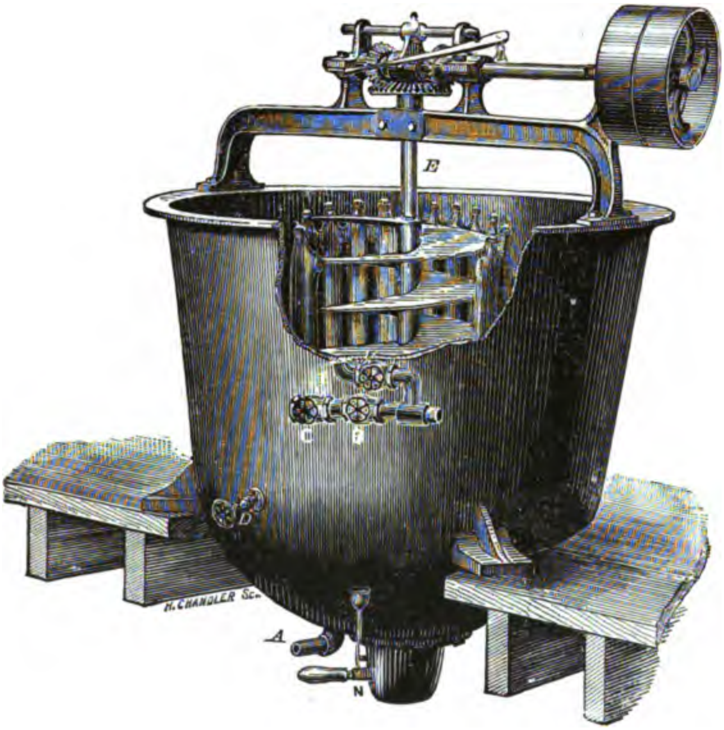


Fig. 30.

jacketed part of the kettle, but can be cut off so that only the inner cylinder has steam. A conveyor screw is placed in the center of this radiator for mixing the soap.

When the machine is to be used for remelting, it is filled with soap scraps, covered up, and the steam at a pressure of about 20 lbs. is turned on ; too high pressure may scorch the soap. As soon as a portion of the soap is melted the screw is set in motion. Open steam may also be turned into the soap to moisten it, if necessary. The motion of the screw lifts the soap and throws it over the top of the radiator and partly forces it through the open spaces between the pipes. The pieces that are too large to pass

in this manner are carried up and wedged in between the open ports, formed by the upper ends of the steam pipes. By the motion of the screw the pieces are sheared off and thus completely cut up.

When required for cooling, cold water may be passed, instead of steam, into the jacket and the radiator. The screw may be run

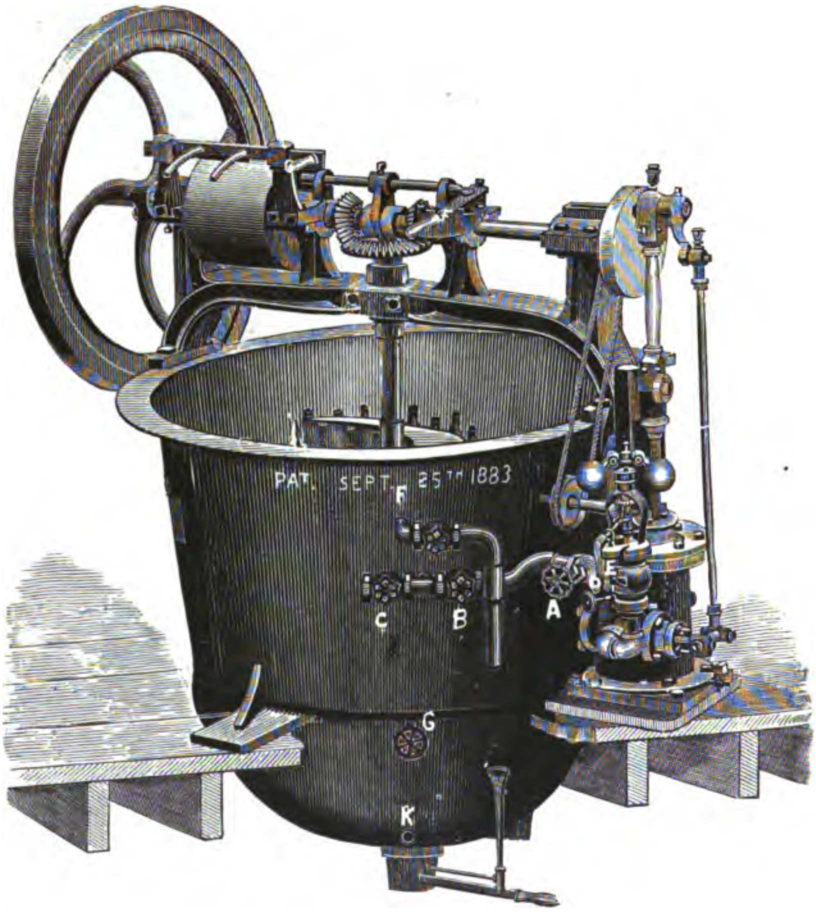


Fig. 31.

forward or backward, the change being effected by simply shifting the gearing. If it is found that the soap has a tendency to become spongy while lying in the hot jacket, steam to the latter must be shut off.

The engine connected with the crutcher, as shown in Fig.

31, is one of eight horse-power, and is, therefore, sufficient not only to drive the machine, but run an elevator, and pump soap at the same time, (or do the latter work alone while the crutcher is not in motion). It dispenses with all shafting, pulleys and belting for crutching, and may consequently be set up in any place desired. All that is necessary is to connect the machine to a boiler having 40 lbs. or more of steam.

It is an extremely convenient apparatus, not only for remelting, but also for mixing and for making soaps by the cold process.

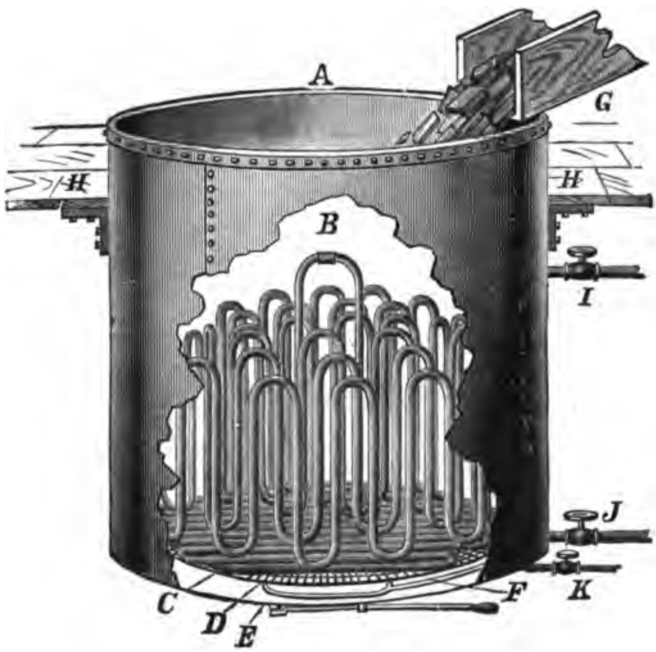


Fig. 32.

WHITAKER'S Remelter. This is a machine specially designed for the remelting of soap, whether for working up scraps or for making remelted toilet soaps. It consists of the wrought iron cylinder *A* into which is set the continuous steam pipe *B* connecting with the horizontal pipe *C*. These pipes rest on a wire netting through which the melted soap may drain off. *F* is a perforated pipe for admitting steam into the soap through the valve *I*. The condensed steam is drawn off by pipe *J*.

When the apparatus is filled with soap it is covered, and open steam turned on. When the scraps begin to melt, the open steam

is shut off, the condensed steam drained off, and closed steam turned on. The melted soap is drawn into the frames as it melts and occasionally crutched through; or the soap is run from the remelter into the crutcher and there worked through before framing.

Accelerating the melting.

The time required for the operation depends on the dryness of the scraps, for the more water the soap contains the more quickly will it melt. Ten to twenty frames of soap scrap can be remelted in a day by this machine, when used as described. In large factories where there is considerable work for the remelter, it is a good plan to provide it with a high "curb" into which the scraps are thrown as fast as they come from the cutting machinery. The pressure of the great amount of scraps above serves to press the remelted soap out quickly, thereby increasing the capacity of the remelter considerably and improving the product. At the same time the curb, if properly arranged, will prevent the rapid drying of the scrap, which circumstance also increases the capacity for remelting. Lastly, the curb may pass through several stories, with doors through which the scraps may be thrown into the remelter, whereby work in handling them is saved.

SOAP FRAMES.

Wood and iron frames.

When the soap is finished in the kettle, and has received the required additions in the crutcher, it is run into the soap "frames" for cooling and hardening. These frames are made either of wood or of iron, the latter being the kind most generally used in this country. Wooden frames naturally retard the cooling of the soap, and are therefore mostly used for special kinds of soap which require slow cooling. The iron frame, as generally used for common laundry soap, is in most cases of a size holding about 1,200 lbs.

WHITAKER's Patent Soap Frame (See Fig. 33) has a wooden bottom and two sides of sheet iron, flanged at their upper edges, and strengthened by ribs of corrugated sheet iron running in the direction of their length on the outer surface; this device prevents the sides from twisting or bending, so that the soap will set in the exact rectangular shape, on cooling. The sides are connected by ends of two inch plank and secured by clamps, allowing of mounting and dismounting the frame almost instantly. In such iron frames ordinary soap cools sufficiently to strip in from 24 to 48 hours, according to the weather and temperature of framing.

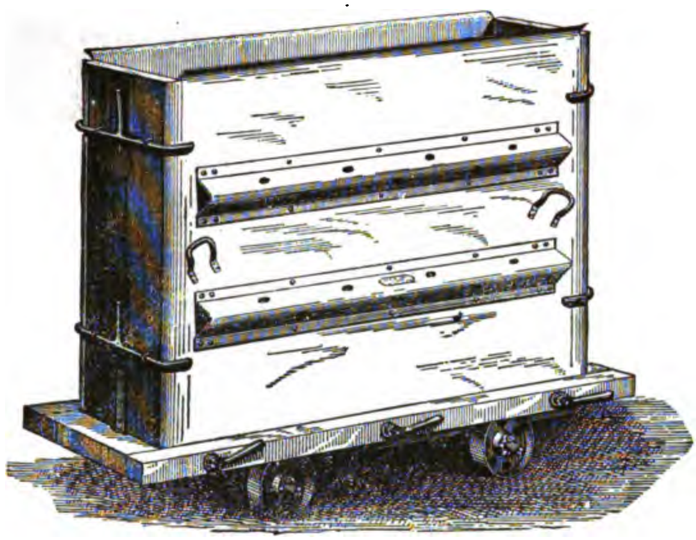


Fig. 33.

DOPP'S Soap Frame. The illustration of this frame explains itself. It is shown in this instance without wheels, trucks being used in many factories for moving them. (These trucks are

Fig. 34.

illustrated hereafter.) Of course, wheels may be placed under this frame if desired. (See Fig. 34.)

HOME-MADE FRAMES: A cheap, convenient, and easily handled, as well as quickly cooling frame may be made according to the following description, given by a writer in the *American Soap Journal.* The sizes mentioned are for a frame holding 1,200 lbs. of soap:

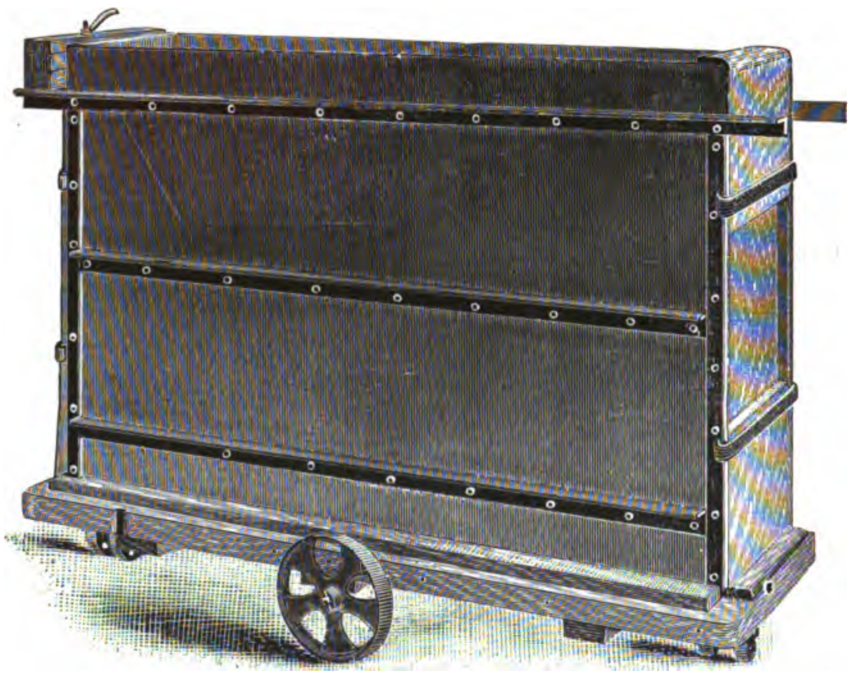


Fig. 35.

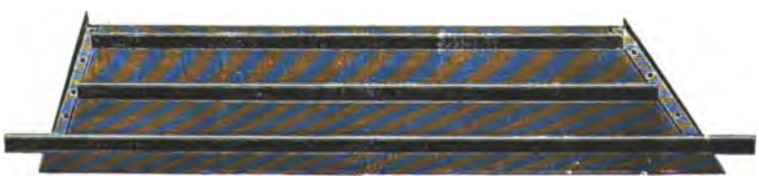


Fig. 36.

Fig. 35 shows the frame ready for use, but empty, the sides being of steel of No. 12 thickness and the ends of wood. The sides have 1½ inch angle irons, running lengthwise, three in number, to strengthen them, and also at each end perpendicularly a tapering angle on which clamps work, to bring the sides up rigidly

when the clamps are driven down upon the tapering angle irons, which near the bottom assumes its full size of 1½ inches in width. On one end of the frame is partly shown a combined wood and iron clamp, one of a pair used only when running the frame away from the crutcher, on and off elevators, and over rough floors while the soap in the frame is still hot.

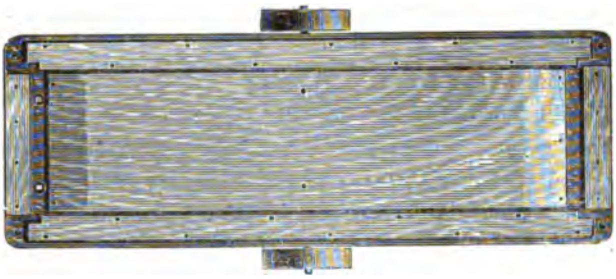


Fig. 37.

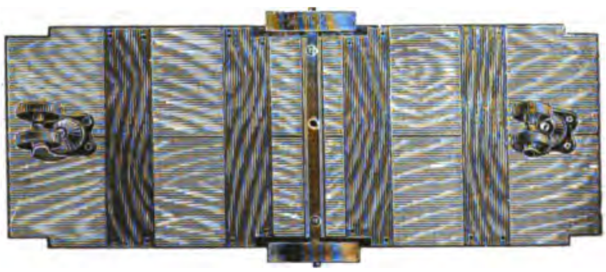


Figure 38.

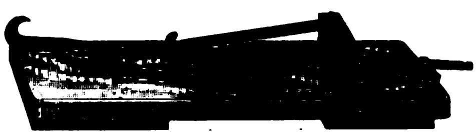


Figure 39.

In this cut is seen one of the center wheels, 9 inches in diameter, on which the frame principally rests; at each end, not distinctly shown in the cut, is a pair of 4½ inch wheels, hung together on a swivel, in the form of a castor, which failing to more than barely touch the floor lightly, if at all, enables the frame to be easily and quickly revolved on its axle. The end pieces are simply wooden planks, say 1½ inch thick with one inch battens as shown.

For convenience in every way a frame of the capacity stated may be made, inside measures, say 54 inches in length, 40 inches in depth, and 14½ inches in width, and in making out specifications for the iron work allowance, of course, must be made in addition to these figures for the thickness of wooden ends, say 5 inches, and for a false bottom of say one inch. One inch axles of steel should be used for the wheels.

Fig. 36 shows the steel side, removed from the frame. This should be made straight and flat.

Fig. 37 shows the frame bottom, top view, which needs no further explanation, as the cut speaks for itself.

Fig. 38 shows the reverse of the same. The bottom may be made of 2 inch plank, 5 feet 3 inches long, 20 inches wide, with say four battens on under side, 2 x 4 inches, and with wheels placed as shown.

Fig. 37 shows cleats 2½ inches in width and a false bottom 54 x 14½ inches, and one inch thick, placed relatively with spaces for receiving and retaining in position the sides and ends.

Fig. 39 shows the steel clamps, one somewhat shorter than the other, at each end of the frame, 2 x ½ inch, curved at ends to fit upon the tapering angle iron on frame sides to hold the whole rigidly in position. It also shows the wood and iron clamp for temporary use, as before referred to. The iron castors can be obtained through any large hardware house. The iron center wheels should be made light, but strong, say of two inch face.

Constructed of steel not unnecessarily thick, these frames are readily taken apart and set up again by even two boys, and when filled with soap they can be easily moved about on a smooth floor, and can be turned completely around within the space of their own length by one boy alone. When set up, the clamps hold them together very rigidly, making a very strong frame.

Track for the frames.

In factories where many frames are used, it is convenient to have a track on which fit the wheels of the frame, so that the soap can be easily wheeled from one room into the other. In this case it may be best to have the wheels so placed on the bottom of the frame that the latter stands crosswise on the track. The size of a 1,000 lbs. frame being about 14 x 56 inches, (and about 40 inches high) much space on the track is saved by having the wheels placed in this manner.

It is also found convenient to have one extra bottom for each frame, for while one bottom is occupied by the block of soap after it has been "stripped," the extra bottom, together with the sides and end pieces taken from the first bottom, can be used for the next framing. **Extra bottoms.**

Where frames are used that have no wheels, they are placed below the crutcher on "run ways," in such a manner that the frame stands high enough above the floor to readily permit of pushing a truck or "buggy" underneath them. This buggy is made of iron and so constructed that, on raising the handle, its frame work is raised sufficiently to lift the soap frame off the run ways. On wheeling the truck to another part of the factory and lowering the handle, the frame is also lowered and placed on similar run ways provided for the purpose near the cutting machinery. **Trucks.**

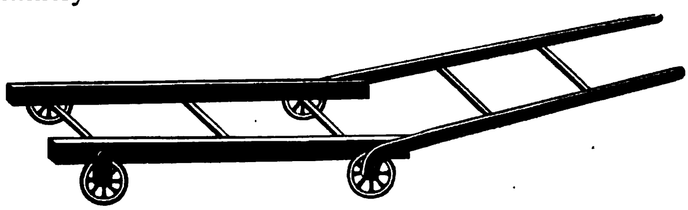


Fig. 40.

Instead of the "run ways," and the special truck described, another contrivance is used in some places which consists of a number of pieces of gas-pipe, through which rods are passed to serve as axles for the pipes which in turn are used as wheels. The axles are placed parallel to each other and their ends secured in a frame-work. The frame bottoms are slighly curved, so that this apparatus can be easily slipped under them.

While the iron frames, as said before, are those generally used for most soaps, some manufacturers still prefer the wooden ones as, on account of their light weight, they are easy to handle; nor do they become rusty and stain the soap, but on the contrary become covered after a short use, on their inner surface, by a glossy enamel-like coating, and therefore strip easily. **Wooden frames.**

For quite small frames, such as are used to advantage for some cold-made soaps, a cast iron box is well adapted, which is cut in half through the sides and bottom. For setting it up, it is only necessary to place the two halves together and secure them by a clamp. **Small cast iron frames.**

THE SOAP SLABBER AND CUTTER.

The block of soap left on the bottom of the frames after stripping is cut into marketable sizes by means of wire. The manner in which this operation was first performed was by marking the block where it was intended to be cut, and simply drawing a wire through it along these marks. In some factories this simple process is still employed, but for large factories a machine,

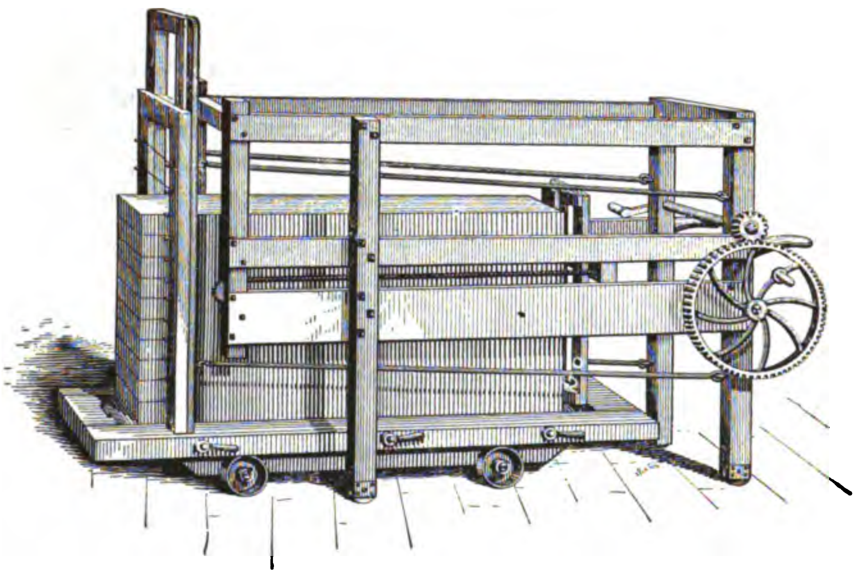


Fig. 41.

somewhat on the plan shown herewith, will be practically indispensable on account of the saving in time and labor effected by it. The illustration (Fig. 41, made by the Hersey Mfg. Co., and known as the "Ralston Slabber") shows how the wires cut the block into slabs in an exceedingly short time and with the greatest possible regularity. The slabber should have a size corresponding as closely as possible to that of the frames, so that the cutting wires are just long enough to cut the block of soap; too long wires are apt to break, owing to the greater tension required to keep them in a straight position.

Fig. 42 is a rough sketch of the principle on which a home-made slabber may be constructed.

For cutting the slabs up into long bars and into cakes, machines of various construction are used, as may be best adapted

to the requirements of the factory. The accompanying Fig. 43 and 44 hardly require further description, the mechanical details appearing plainly; nor can we describe all the forms of this machine in use, since they are frequently made according to order, to comply with individual needs and preferences.

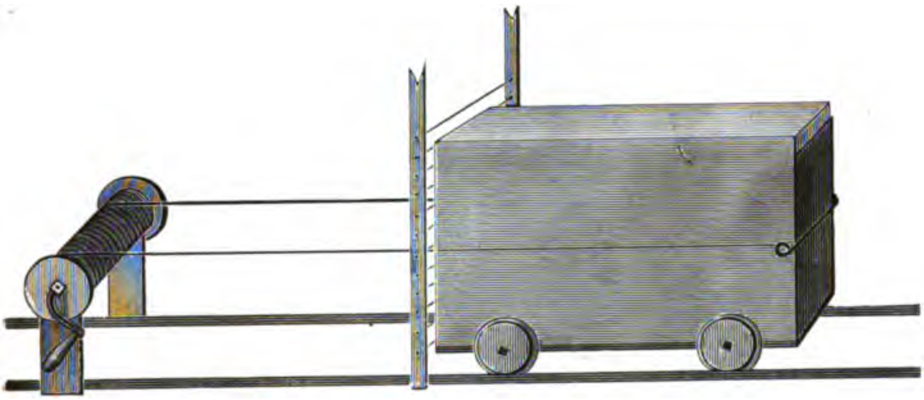


Fig. 42.

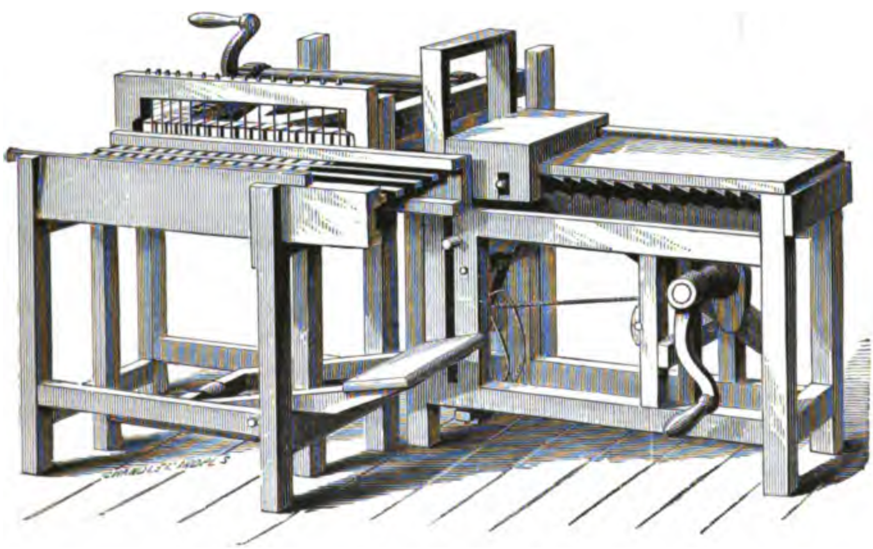


Fig. 43.

Fig. 43 shows a soap cutter made by the Hersey Mfg. Co. of Boston.

Parallel staves are generally provided (see illustration) for the bars of soap to slide on after being cut; this arrangement is called

a "spreader," as by drawing the staves endwise the bars are spread slightly apart, in order to facilitate drying on the rack, by allowing the air to circulate freely among the bars.

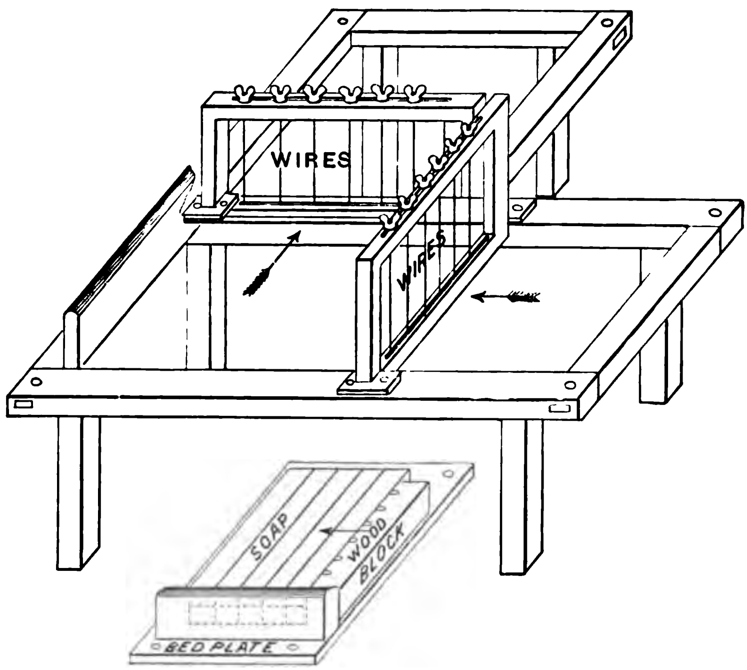


Fig. 44.

Fig. 44 represents a set of iron cutting frames, as made by H. Wm. Dopp & Son of Buffalo. These frames are made of cast iron, and the wires are fastened and spaced as desired by means of thumb-screws. The frames are fastened by bolts upon a wooden frame as shown, and wooden bed plates must be provided for on the latter, as shown in the small engraving forming part of the same figure.

As will be seen, the preceding machinery is run by hand, but there have also been made a few machines after a special pattern shown on page 113, operated by steam power. (See Fig. 45.)

This machine slabs, cuts, racks, and spreads an enormous amount of soap per day.

The wire used in these cutting machines is what is known as "piano-wire," which combines the greatest strength with durabil-

ity, and is best adapted for the purpose because the thinner the wire the smoother will be the cut.

For cutting cakes from single bars the machine shown in Fig. 46 is a convenient arrangement.

* * * * * *

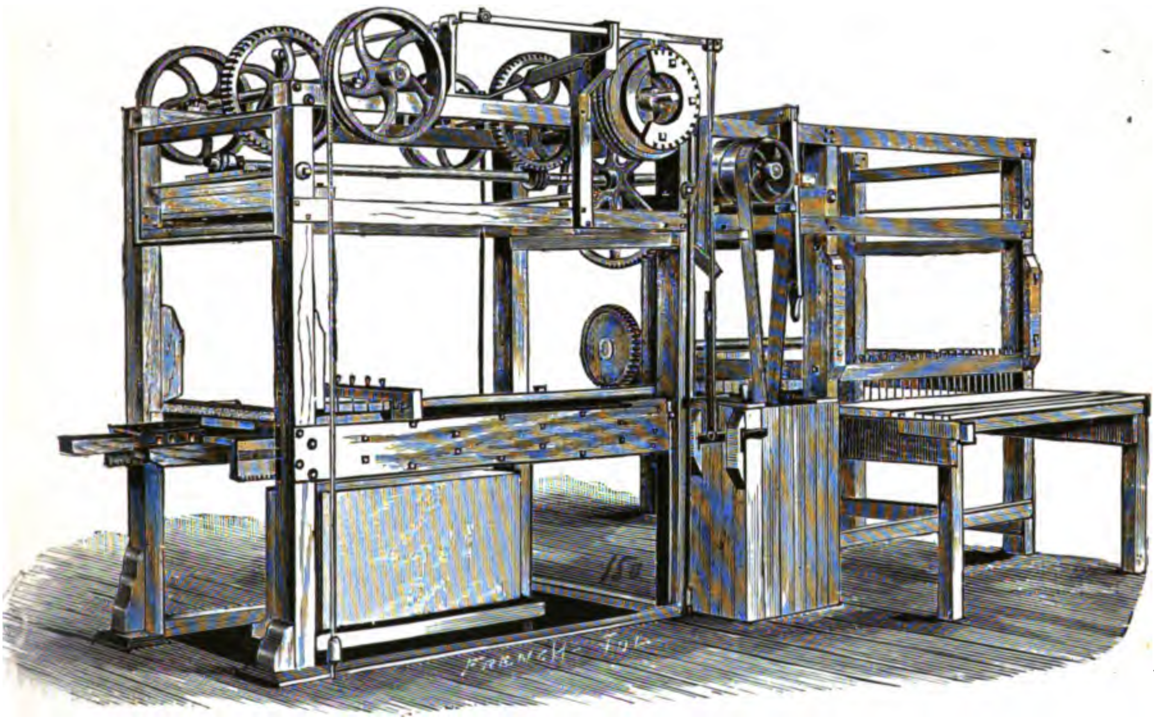


Fig. 45.

In the case of toilet soap, before pressing the cakes, (if they are to have a smooth surface) the bars after cutting and slightly drying are sometimes planed by drawing them over a machine arranged like an ordinary carpenter's plane turned upside down, which takes off a thin shaving and leaves the surface of the bar very smooth, giving the cake after pressing an improved appearance and decreasing its tendency of sticking to the dies in pressing. **Planing the cakes.**

Instead of wire for cutting the slabs into bars, steel knives or springs placed similarly in the cutting machines have been recommended. It is difficult to keep them from bending under the strain of cutting, and they are not widely used; but those who **Knives for cutting in place of wire.**

have tried them claim that they make a smoother cut than does wire.

Fig. 46.

The thinner the cutting wire, the smoother will it leave the surface of the soap.

DRYING APPARATUS.

Natural drying.

After being cut into bars the soap requires to be dried somewhat in order to be in a marketable condition and ready to be pressed. This drying process is in many factories still carried out by simply placing the bars on racks and leaving them there exposed to the atmosphere until in the proper condition. This, of course, is an unsatisfactory method, as the changes of the weather render it very uncertain and tedious, besides being slow at best and requiring considerable room. A somewhat improved result is secured from drying rooms in which steam coils are placed to raise the temperature; here also, however, the air in the room becomes laden with moisture, and unless removed promptly, the drying still proceeds in an unsatisfactory manner. The best results are derived, undoubtedly, by combined heating and ventilation. Currents of dry, warm air, directly acting on the soap, hasten the process and dry the soap in a most satisfactory way, causing the for-

Artificial drying.

mation of a firm, glossy skin over the surface which greatly aids in pressing the cakes and enhances their fine appearance. For this purpose a "blower" or "pressure fan" is placed before a steam coil (which may be heated with exhaust steam of the engine) and connected air tight with a casing surrounding the coil. On admitting air into the inlet of the fan it is forced through the bends of the coil and its temperature thereby raised. As is well known hot air can absorb more moisture than cold air, and therefore whatever the weather may be, the soap is sure to be dried by directing the warm current upon the racks. From 6 to 12 hours' drying is ordinarily sufficient to put the soap in condition for pressing, whereas in the old way the time required is very indefinite.

A convenient method of connecting the operations of ventilation and heating, for drying soap, is shown in the accompanying drawing. The latter represents a coil of 1 inch steam pipe (not

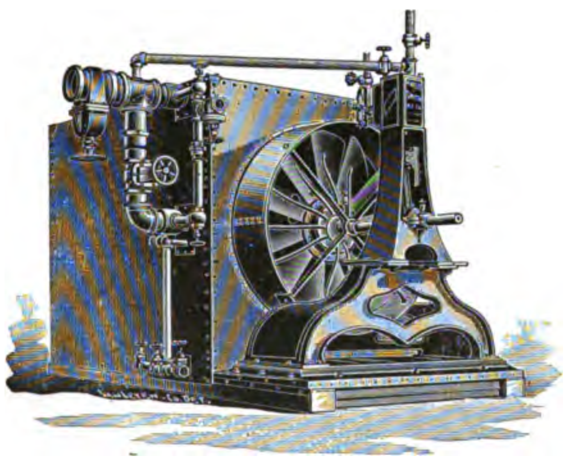


Fig. 47.

shown) in a casing of sheet steel to which is attached a disk fan. The temperature of the air forced through the casing can be regulated, and is generally kept at about 100° F. for soap. The soap in the drying room into which the hot air is forced, may be placed on drying racks or on cars which may be gradually moved forward to the hottest part of the room as the drying proceeds.

A similar apparatus, made by the Buffalo (N. Y.) Forge Co., is illustrated in Fig. 48, and requires no further explanation.

It is suggested that in warm weather the coils of pipe may be filled with brine, which has the effect of condensing the moisture in

the air, thereby rendering its drying capacity, in passing over the soap, greater. When the air is naturally in good condition for drying, the coil may also be left out of use altogether, the fan only being used for ventilating the drying room.

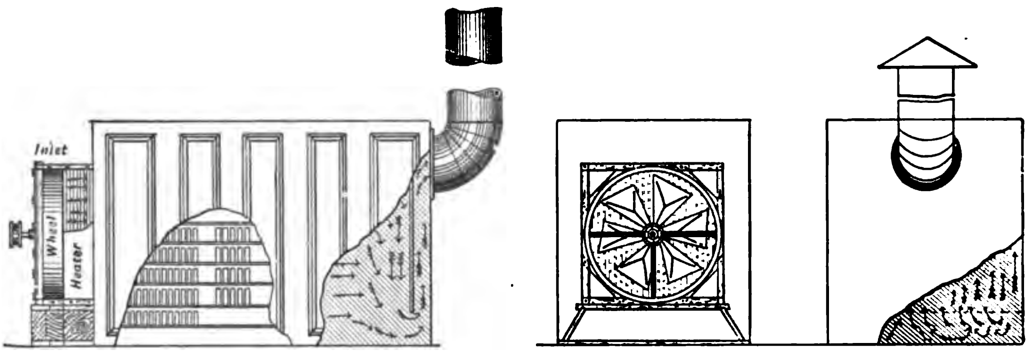


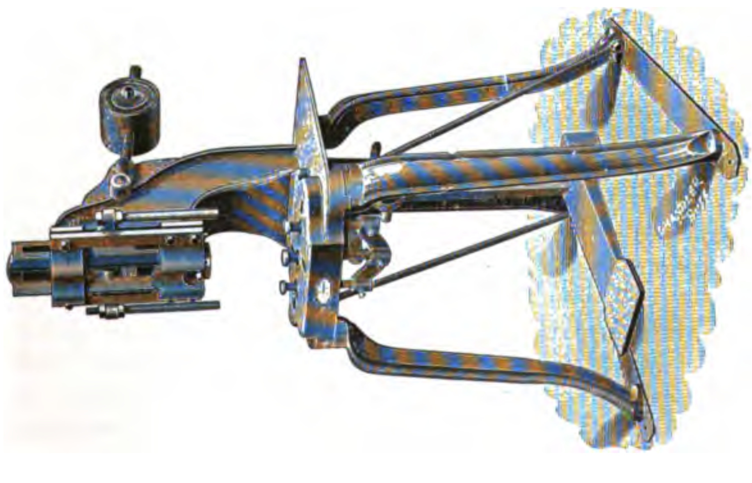
Fig. 48.

THE PRESS.

For forming the bars of soap into cakes, presses of great variety have been constructed, ranging from the small hand-press which stamps a few hundred cakes per hour, to steam presses having a capacity of several thousand cakes in the same time.

The machines used in most cases are operated by foot power, the steam presses being mostly reserved for the larger factories which turn out large quantities of a few special brands of soap. Hand-presses are used but little in this country, where labor is generally too expensive for their slow work.

In selecting a press, regard is had not only to the requirements of the factory as to capacity, but also to the special kind of soap for which it is to be used, for while most kinds are best pressed by a machine giving a sudden blow, others, it is claimed, form a better cake when compressed by a more continuous pressure, such as is given by the downward turn of a screw. If, as is generally the case, the press is to be used for various sizes of bars, the ready adjustment for different dies, and also for the force of the blow is to be considered. Ease of working, noiselessness, and stability are essential features, and it is also absolutely necessary that the guide for the dies be perfect, to insure the latter against undue wear. Lastly the arrangement for lifting the cake from the lower die must be so as to insure against defacing the impression by forcibly ejecting the cake against the top die.



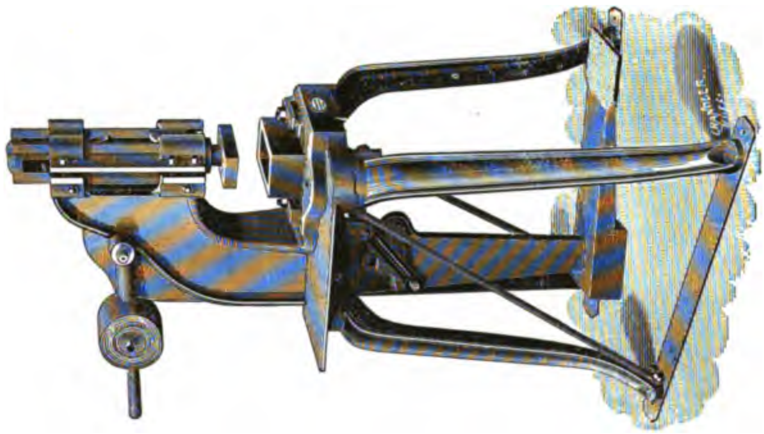


Fig. 49. H. Wm. Dopp & Sons' Foot Presses. Fig. 50.

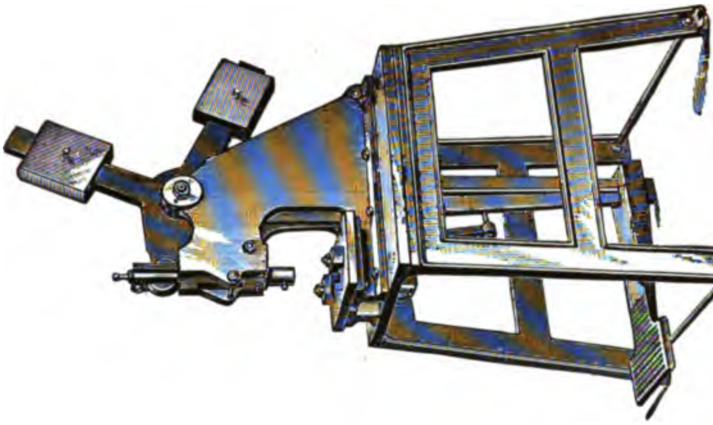


Fig. 51—Rutschman Bros.' Foot Press.

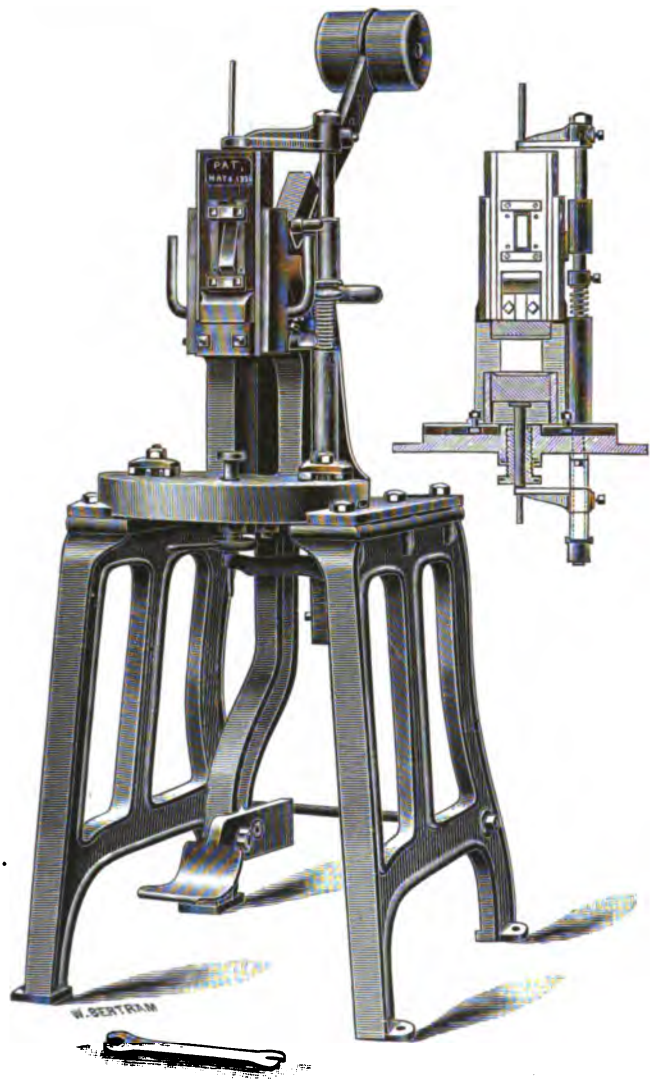


Fig. 52—G. A. Crosby & Co.'s (Challenge) Press.

Herewith are illustrated a number of different soap presses, for foot and for steam power; it would lead too far to go into detailed descriptions of the same and their respective claims for superiority; we therefore contend ourselves with their illustration.

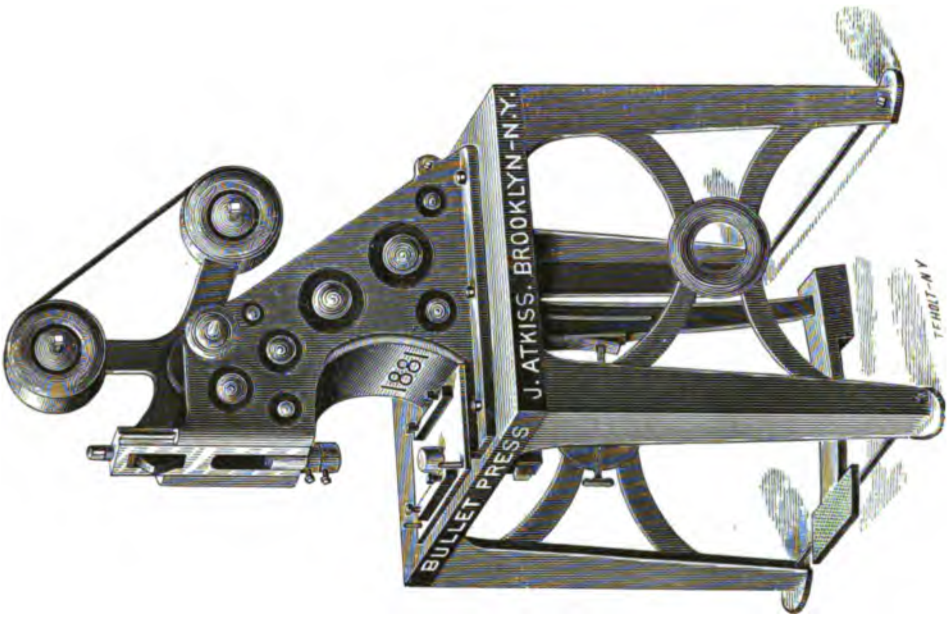


Fig. 53. Brown & Patterson's (Atkiss) Foot Presses. Fig. 54.

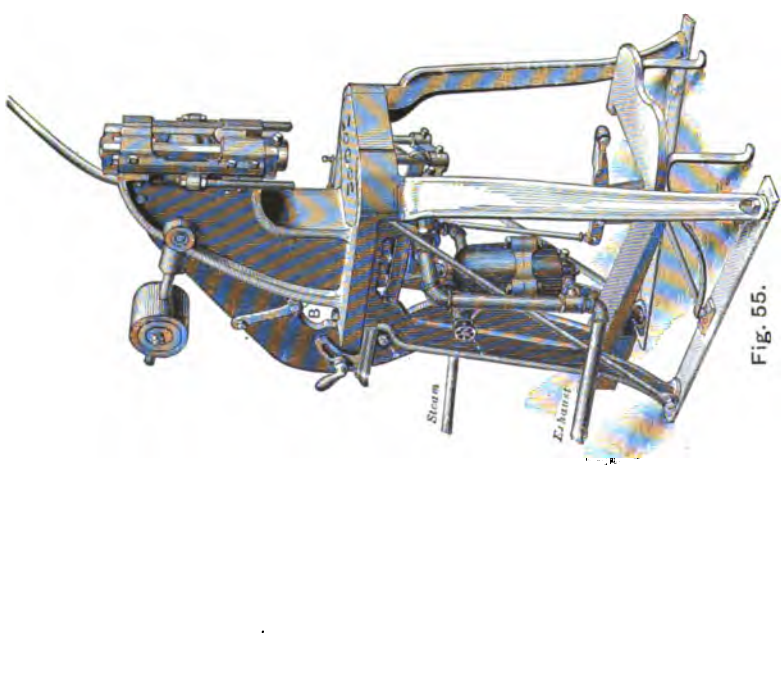


Fig. 55.

H. W.n. Dopp & Son's Steam Press.

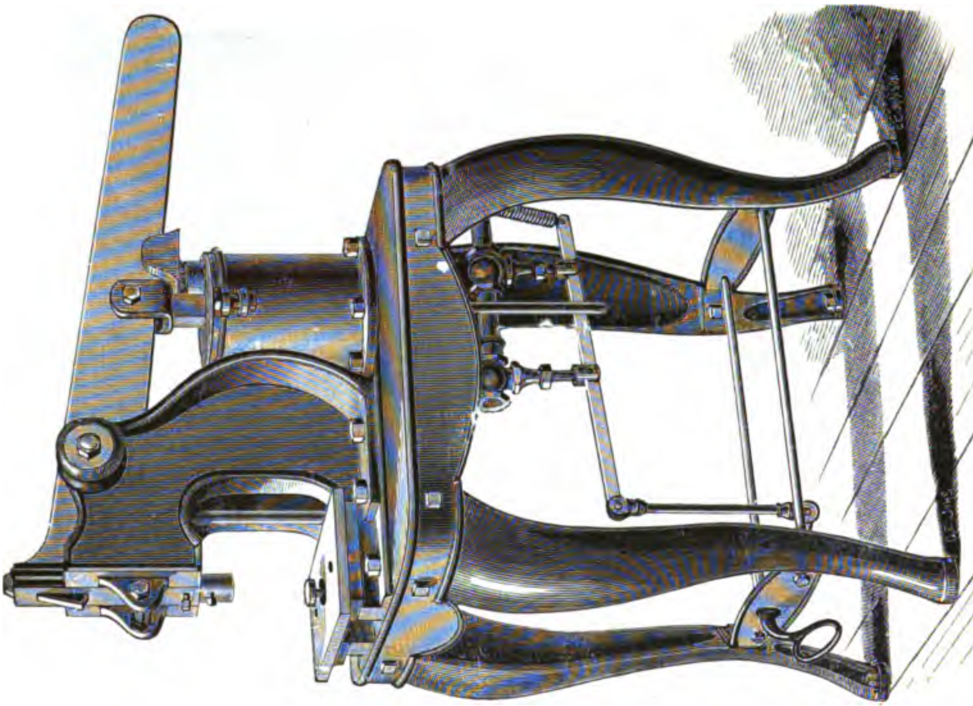


Fig. 56.—Hersey Bros. Mfg. Co.'s Steam Press.

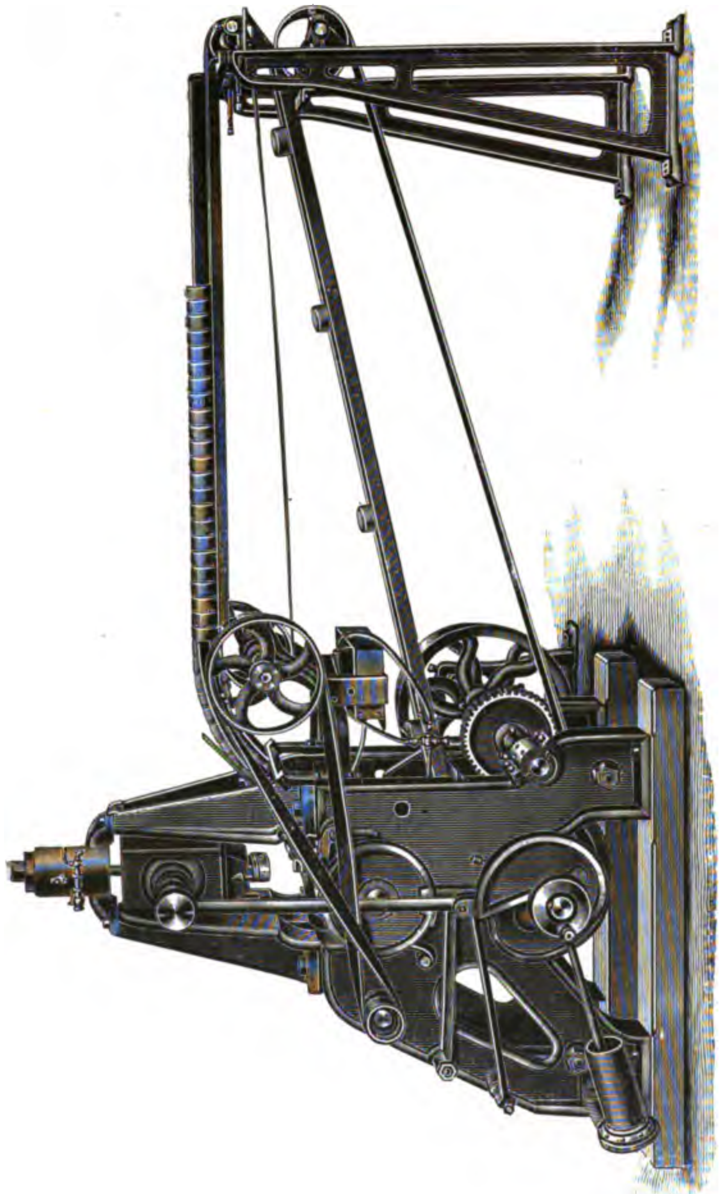


Fig. 57.—Hersey Bros. Mfg. Co.'s Automatic Feed Steam Press. (See page 122.)

Fig. 57, on page 121, represents a press which requires a few words of explanation, as it is a recently perfected machine. In this press the soap is handled automatically, that is, it is fed into the press and delivered therefrom by belts, dispensing with the labor of putting the soap into the press a cake at a time by hand. The cakes from the cutting machine, after having been suitably dried on the racks, are placed on the upper belt shown in the cut and are delivered on to the lower belt after being pressed; from the lower belt the soap may pass to a table, or the belt may be continued in a horizontal direction, from which belt the soap is taken, wrapped and put in boxes immediately, the boys engaged in wrapping standing on either side of the belt and taking the soap as it comes along.

The press is entirely automatic, feeding and delivering the soap by the mechanism perfectly, and it also thoroughly lubricates and cleans the dies between the pressing of each cake. It has a capacity of 360 boxes of soap of 100 cakes each per day of ten hours. The saving of labor in the use of an automatic press will no doubt prove a very considerable item. The press is adapted to the pressing of all kinds and shapes of laundry soaps; the dies can be readily changed from one style or shape to anotner, and the pressure can be regulated at will.

THE DIES.

The dies in which the cake of soap is formed in the press require careful consideration, for on their construction depends in a great measure the appearance of the finished article, a matter which has come to be of considerable consequence.

The material used for their construction is generally gun metal, which altogether appears to be most serviceable for the purpose. The working parts must be very accurately fitted in order to make a clear impression and to form faultless cakes. The boxes must be perfectly straight, so that the pressed soap may be removable without difficulty; they are generally made entirely of gun metal, and sometimes of iron lined with brass. The design should be cut so that the dies will readily release the soap, and that the fine edges of the design will not easily break. A highly polished finish of the dies insures cakes of soap of a fine gloss, with a minimum tendency to stick to the dies. For this reason nickle-plated dies are sometimes used, especially in Europe, which

answer the purpose admirably and have the further advantage of not staining the soap as sometimes occurs when ordinary dies are used.

The dies in use may be divided into two principal classes, namely box dies, and pin or shoulder dies, of which illustrations are given herewith.

The box dies (Fig. 58, 59) consist of an upper die, a lower die, and a box. The lower die is movable, and by raising it in the box the pressed cake of soap is ejected automatically.

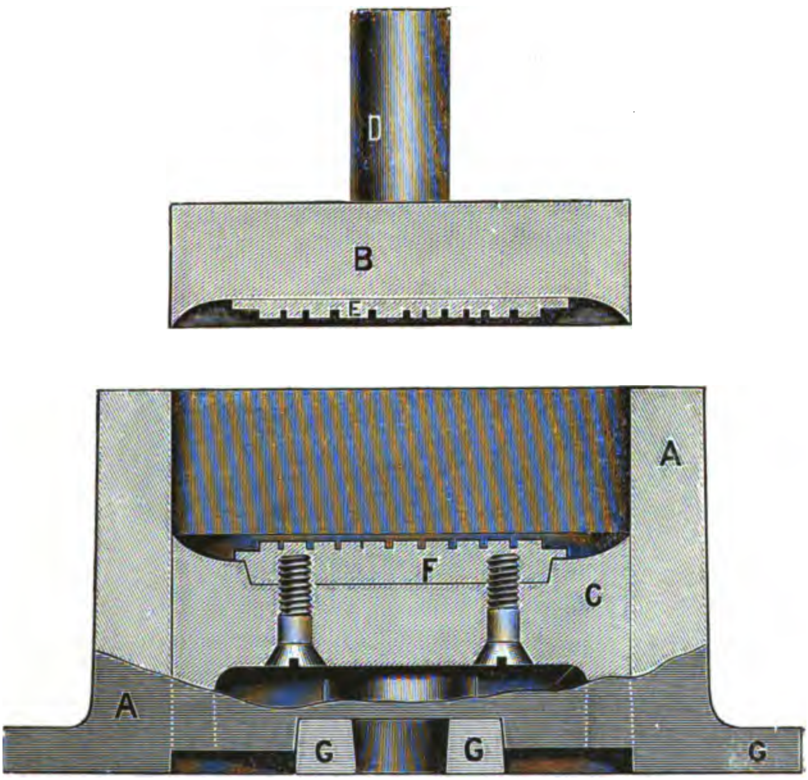


Fig. 58.

A—Box. B—Upper Die. C—Lower Die. D—Shank. E—Fixed Panel. F—Changeable Panel. G—Flanges.

The pin or shoulder die (Figs. 60, 61) consists of upper and lower die, and has guide pins and holes to secure the proper relative position of the dies to each other on closing. Both dies have sharp edges, which, on meeting, cut away any soap in excess of

Fig. 59.

that required for the cake to be formed. The shoulders prevent the edges from injuring each other. Dies of this description are

Fig. 60.

generally used only for the better grades of milled toilet soap, as they do not give very satisfactory results with the lower qualities of soap.

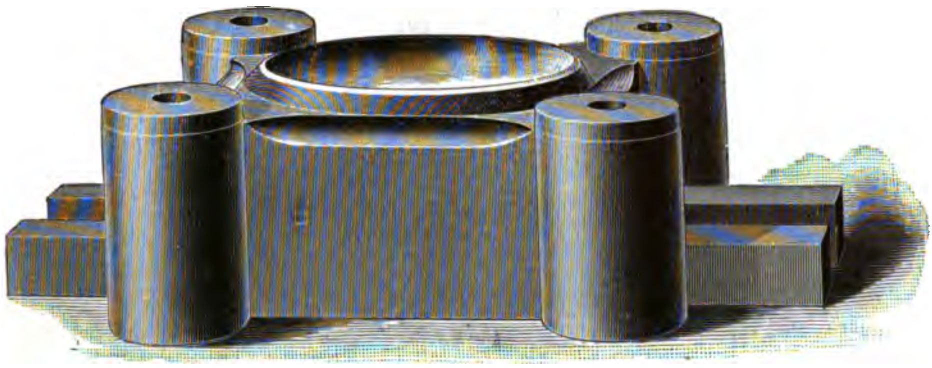


Fig. 61.

Figures 62 and 63 show a combination die (Christy's patent), which consists of upper and lower die and a box, but also has a separate piece, by the insertion of which the box die is changed

Fig. 62.

into a shoulder die. Used in either way, the surplus soap is pressed out, making all cakes of uniform weight.

Figures 64 and 65 represent Christy's self-adjusting die, in which the ordinary die is provided with guide pins which guide the upper die into its place, preventing risk of damage to the edges.

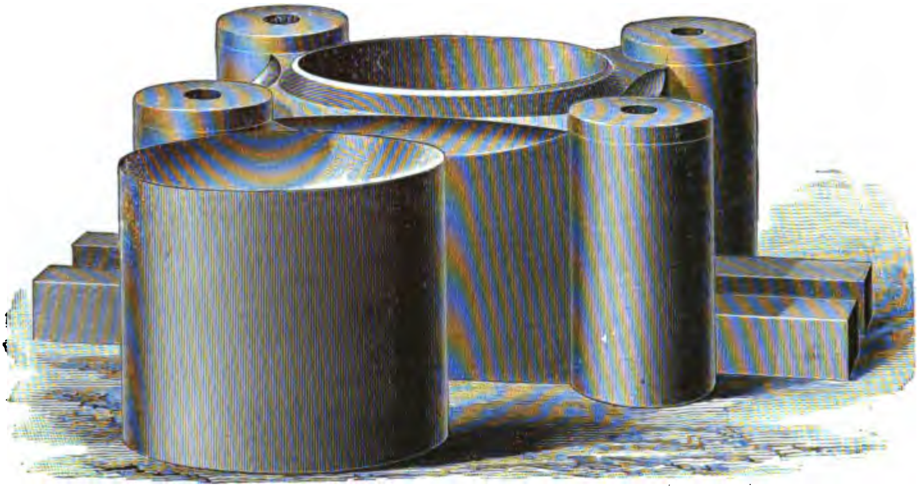


Fig. 63.

In most dies it is practicable to have an exchangeable panel instead of a solid lower die. This enables the same set of dies to

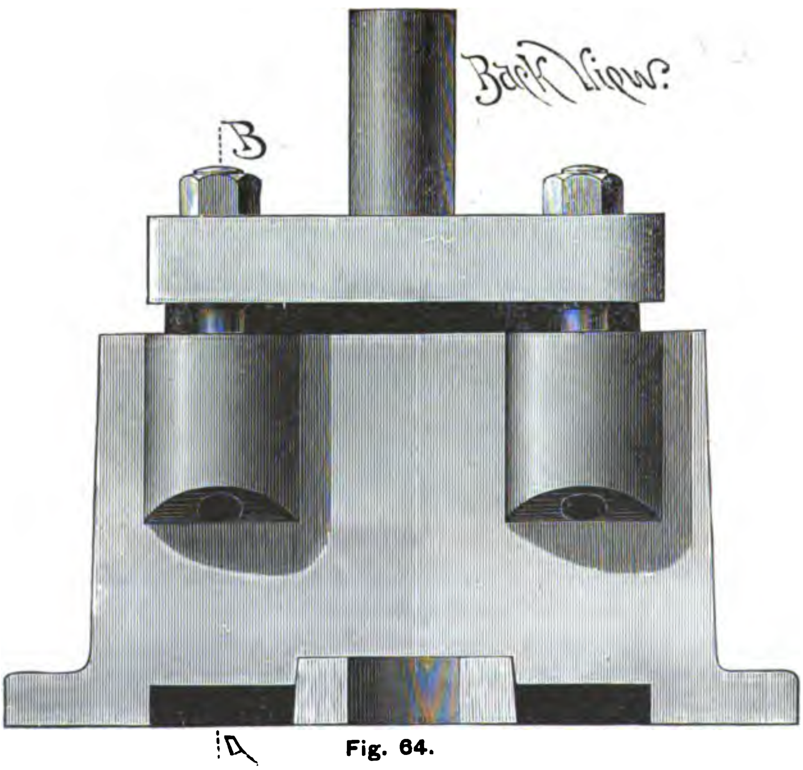


Fig. 64.

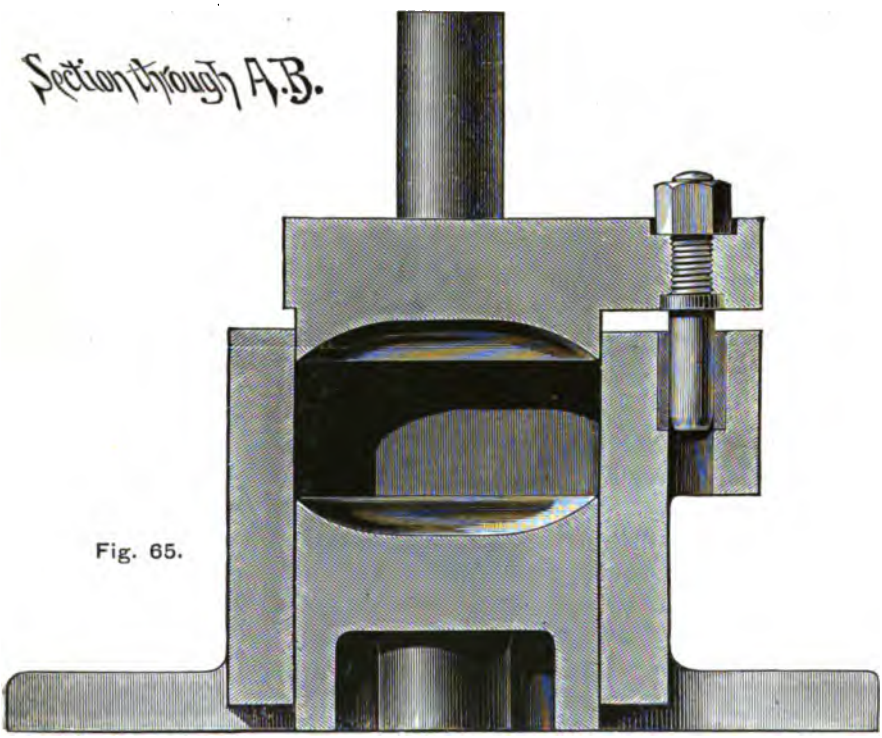


Fig. 65.

be used for a number of different brands, by simply changing the panel on which the name of the soap is engraved. The firm name is generally engraved on the top die.

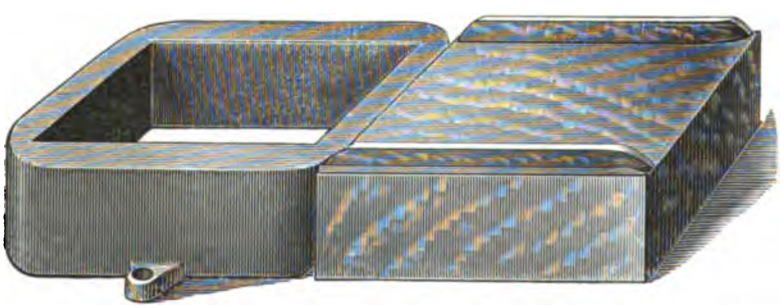


Fig. 66.

In this connection we illustrate herewith (Fig. 66) a very simple device for protecting the workman against a common form of accident while pressing soap, in which operation a great many

people have been more or less seriously injured. To prevent the workman from cutting off his fingers in the press, a block of wood is fastened to the right of the die box, conforming in size to that of the latter. Guides are provided in the form of two strips, curved at the end to permit the bar of soap to enter readily. A bar is placed on the block and then pushed on the die box by another cake to be pressed next. When the first cake has been pressed the workman can safely remove it while the top die is up; then the second bar is in turn moved forward by a third one being placed on the block, and so on. After the workmen are once used to this arrangement there is no trouble whatever arising from the use of this safeguard.

An improvement in this direction has been suggested which consists in depressing the wooden block about a quarter of an inch below the surface of the die box, and cutting away the adjoining side of the die box to the level of the block. In this case the cake of soap may be fed forcibly to the opposite side of the die box and held there momentarily by a light pressure on the extra cake; it will then fairly drop in on withdrawing the extra cake. Still greater safety is obtained by attaching to the face of the block an upright piece which will prevent the operator's hand from passing over the die box when feeding the press. The work of the operator may be facilitated by having the block at least twice as long as the cake to be fed. This would enable him to place a cake upon the block with his right hand while the left hand is feeding the preceding cake in the manner described.

The operation of pressing soap and the proper care of the dies will be described in a succeeding chapter, but while on the subject of safety it should here be mentioned that in feeding the ordinary press, without the safety devices described, the workman should *invariably* handle the soap with the thumb and *index finger* of the hands, grasping the bars midway between the upper and the lower surface. Nearly all accidents that occur are the result of handling the soap by grasping the bars with the thumb and middle finger, letting the index finger project across the cake, and thus exposing it to the danger of being cut off.

Fig. 67.—(See page 130).

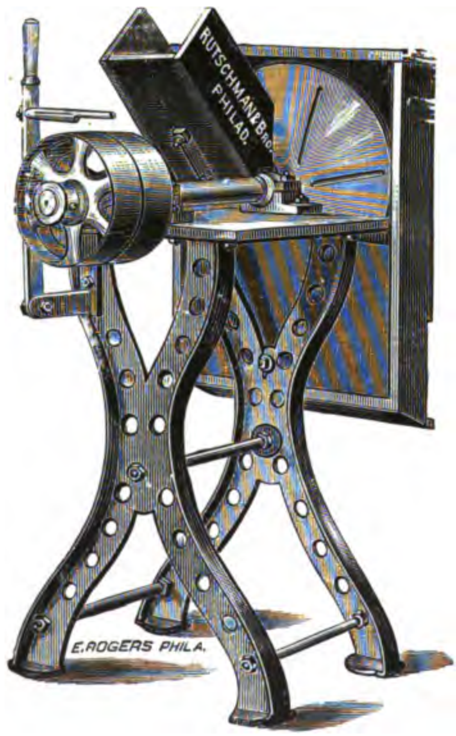


Fig. 68.—(See page 130).

THE SOAP CHIPPER.

Instead of forming the soap into stamped bars, it is often chipped up, especially for use in laundries, or when it is to be "milled." Fig. 67 and 68, show machines used for this purpose; the former is made by Brown & Patterson of Brooklyn, N. Y., and the latter by Rutschman Bros. of Philadelphia.

The soap placed in the hopper is fed automatically to the knives. The latter are adjustable to cut different thicknesses.

* * * * * *

It only remains now to merely mention the simple tanks used for special purposes, as for bleaching, for measuring and storing oils, for making sal soda solutions, etc., and the ordinary machin-

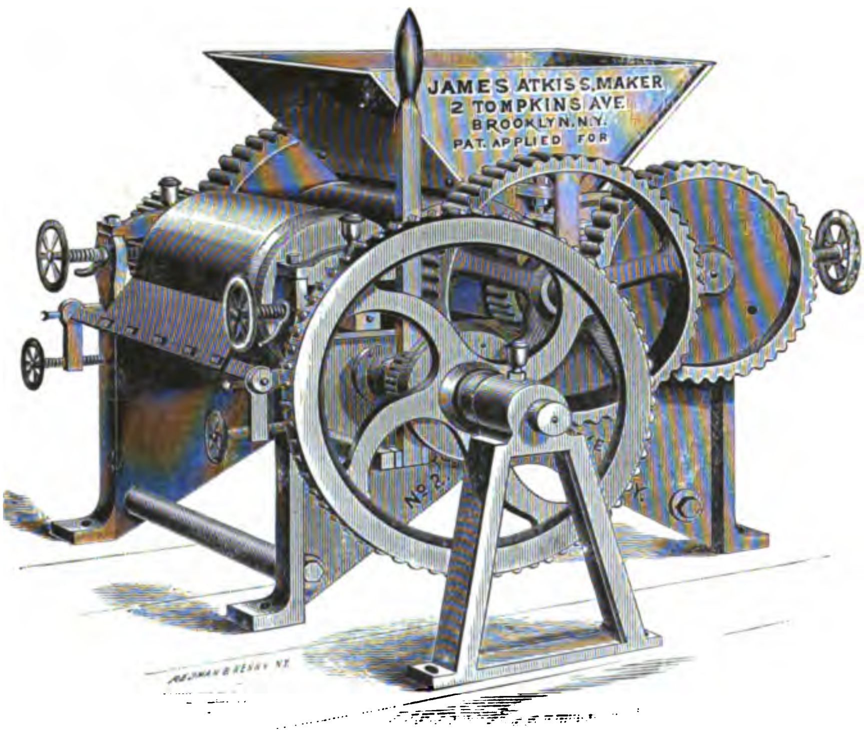


Fig. 69.

ery used in all kinds of factories, as elevators, boiler, engine, shafting, etc., and we may close this chapter, so far as a laundry and ordinary toilet soap factory is concerned.

There are, however, the following special machines still to be considered for factories making "milled" toilet soaps.

THE SOAP MILL.

For making the finest quality of toilet soap the process known as "milling" is employed. The advantages of the same are obvious when it is considered that thereby perfume may be added to the soap when cold, that the soap is dried thoroughly before milling and therefore does not warp or shrink in the least, nor lose weight, and that soap in generai is improved by repeatedly working it over.

The bars are chipped up, thoroughly dried and then fed into the mill where the soap is ground together with the perfume and color

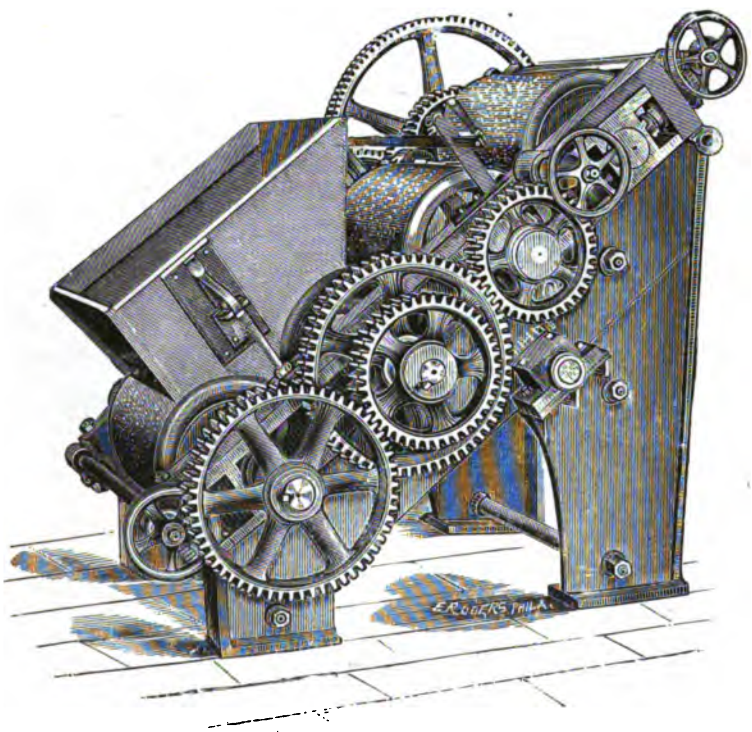


Fig. 70.

desired. The mixture is passed several times through the machine until perfectly homogeneous. From the last roller the soap comes in a thin film that is cut automatically into narrow ribbons, which fall into a box placed under the machine.

The mills are made in various sizes and styles closely resembling each other, so that the illustrations presented on page 130-131 will answer for all. Fig. 69, represents a mill made by Brown & Patterson of Brooklyn, N. Y. Fig. 70, is a mill made by Rutschman Bros. of Philadelphia.

THE PLODDER.

This is a machine into which the soap is fed as it comes in ribbons from the mill, in order to form it, by an enormous pressure, into compact bars. Formerly machines were used which had to be refilled after compressing a small quantity of soap with which they were charged. At present, however, continuous plodders are in general use, from which the soap issues in one continuous solid

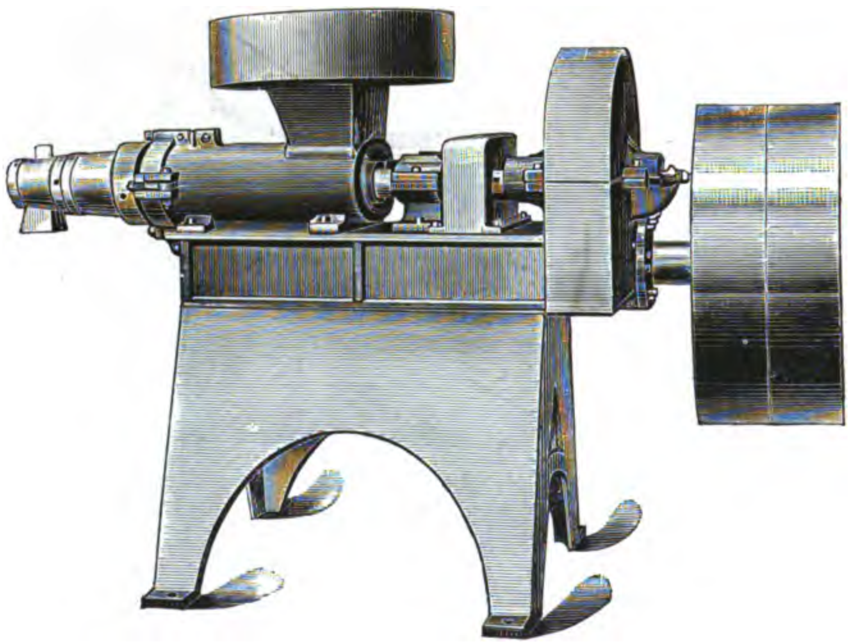


Fig. 71.

bar, so long as more soap is fed into them. The soap, compressed by means of a screw which works the contents towards the outlet, issues from the nozzle seen at the left of the illustrations herewith, (Figs. 71-72) and may at once be cut up into bars and pressed into cakes, without requiring drying. The opening in the nozzle may be given any desired shape by means of different dies, so as to

approximate the shape of the cakes to be formed, and is kept warm by means of a gas flame, so that the soap will come out smooth and glossy.

These plodders are made with a jacket through which cold water may be circulated to prevent the machine and the soap from becoming hot through continually working the latter under so high

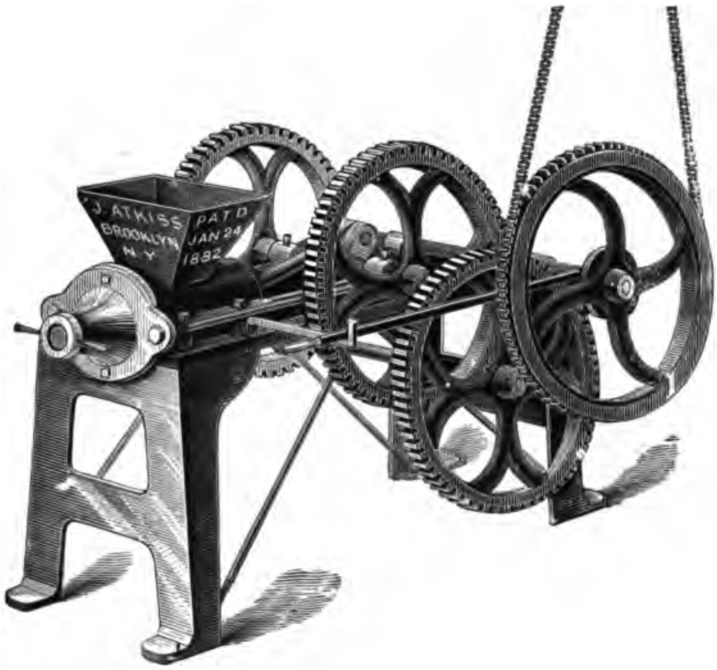


Fig. 72.

a pressure. It is found, however, that when heating actually does occur, the best results are obtained by simply allowing the machine to rest until it cools off by itself. The bar of soap coming from the plodder is cut into short pieces, corresponding to the size of the cake, by means of the cutter illustrated on page 114.

Fig. 72, represents the Atkiss plodder, made by Brown & Patterson of Brooklyn, N. Y. This machine, at each stroke, forces out a bar of soap from 3 to 5 feet in length. Its motion is continuous and the feed automatic.

* * * * * *

A new system of making milled soap has been patented by a firm of soap manufacturers in Belgium, consisting of machinery in

which by means of a system of hollow cylinders revolving at increasing rates of speed, and through which the air circulates, hot soap directly from the kettle may be cooled down to the "setting" temperature in a very few minutes; it is then carried on endless belts into a drying chamber into which hot air currents are introduced and from which it emerges sufficiently and evenly dried ready for the plodder. The perfume and color are added in a special mixing vessel just before the soap is brought upon the cooling cylinders. This system has not as yet been successfully introduced into the United States, but is reported to give fair results in several European factories, as it saves the time, labor and space now required for framing and cooling the soap in large blocks, only to heat it again for drying purposes after chipping it up. See illustration of this system opposite page 87.

* * * * * *

The smaller utensils, such as hand crutches, buckets, etc., have been so frequently described and are so fast disappearing in their use that a description is hardly necessary here.

PART II.

CHAPTER VI

The Manufacture of Soaps.

SELECTION OF MATERIALS AND METHODS.

On commencing the actual manufacture of a soap, a number of questions present themselves for the consideration of the manufacturer, which he must determine beforehand in order to obtain the desired results. Soaps for different purposes require different raw materials; the different treatment of the various materials requires different manufacturing facilities. Again soaps of certain characteristics are made by special selection of materials and methods, and according to the equipment of a factory different means must be adopted at times for reaching the same or similar results. Closely interwoven with all these and other questions is always the matter of cost.

We will here make a systematical survey of the preliminary questions to be answered.

FOR WHAT USE IS THE SOAP INTENDED?

This is undoubtedly the first question to be decided, as the adaptability of the soap to the purpose for which it is to be applied is important above all other considerations. It is obvious that a laundry soap must possess different qualities from a shaving soap, and that a tooth soap will not be popular if made on the lines which are applicable to a first-class scouring soap.

Stock for laundry soaps.

Laundry Soap, as most popular in this country, is generally made of tallow and a moderate proportion of rosin. The tallow may be partly or wholly substituted by grease, cotton seed oil or foots, palm oil, red oil, cocoanut oil, etc. The basis of this soap are the fats named, while rosin is used partly because it is cheaper than fats, and partly because on account of the easy solubility of rosined soaps they wash more rapidly than soaps made wholly of fat. The better grades of this kind of soap contain about 35 lbs. of rosin to hundred pounds of fat, too large amounts of rosin

Effect of rosin.

being undesirable in a soap as making it too soluble and sticky, and leaving it with too little of the fat soap in which, after all, lies the principal value of a good article, so far as washing power is concerned. An addition of rosin just large enough to effect its purpose is perfectly legitimate, and the evident preference of most consumers for such soaps refutes the argument sometimes made that rosin, even in small proportions, should be considered an adulteration. As by the addition of rosin the soap is softened somewhat, it is generally hardened by adding (in the crutcher) a strong solution of sal soda which, by crystallizing in the soap and by a peculiar effect on its structure, renders it harder. In washing this soda also aids in the cleansing effect of the soap, partly by promoting its solubility and partly by its own detergent properties.

Hardening by sal soda.

Unfilled laundry soap.

Some soaps are also made of fat and rosin, without filling; where their slightly slower work is not objected to, they may be considered as ideal laundry soap (provided soft water is used with them), particularly in this country where the climate is such that a pure tallow soda soap would soon dry out to a point where it would become practically insoluble. Laundry soaps differ from toilet soaps in many particulars; for instance, they are not generally required to be entirely neutral, a somewhat alkaline soap being more effective, especially in localities having very hard water; they are less elegantly perfumed, are sold at considerably lower prices, and less predominance is given to their fine appearance. Nor are laundry soaps generally required to produce so rich a lather, and so rapidly, as is demanded of toilet soaps.

Besides personal preferences are divided between rapidly washing or mild, very soluble or economical, cheap or good soaps; in these respects the demand of the customers must be the guide of the manufacturer.

Neutrality of toilet soap.

Toilet Soaps are, or rather should be made, entirely neutral, as any excess of alkali present that is not combined with fat into soap attacks the skin while washing and renders it rough. Great care is therefore required in making a good grade of toilet soap, that the fats employed shall be thoroughly saturated with lye, without any free alkali being left in the soap when it is finished. Similarly the addition of filling, particularly such as carbonate of soda, pearl ash, etc., is much more appropriate for laundry soaps than for toilet soaps.

Stock for toilet soap.

The fats employed for making toilet soap must be selected with regard to the properties of the soap which they form with lye. Thus tallow-soda soap lathers too slowly to be used

alone; pure cocoanut oil soap lathers very freely, but its continued use is not borne by every skin without having a bad effect, and its smell is peculiarly unpleasant; grease is too impure, generally, to be made into a soap that will preserve its fine perfume and not turn rancid in course of time. It will be seen from this that for making good toilet soaps special consideration must be given from the start to the selection of the fats, to their proper treatment, to a process of making them into soap actually free from uncombined fat and lye, and to their appearance, color, texture, and perfume, which are of far greater importance, commercially, in this kind of soap than in the grades for ordinary household use.

Potash in toilet soap.

The use of some potash in place of some of the soda is of quite noticeable advantage in toilet soaps, as it improves the texture, and also its lathering properties, on account of the greater solubility of potash soap.

For trade in many country places a soap is required which, while cheap enough for household purposes, shall also be fairly good for personal ablution. This demand is frequently filled by soaps which are neither one nor the other, combining the properties of a somewhat mild laundry soap with those of a rather poor toilet soap.

It will be seen that toilet soaps vary from the soaps for ordinary uses only in the selection of the best materials and more careful manipulation; but people having a healthy, tough skin, frequently can use even a somewhat alkaline soap with immunity, and many cheap soaps are sold for toilet purposes which in point of purity and mildness are even behind some of the laundry soaps in the market. For people with sensitive skins, and especially ladies and children, the use of such articles is often attended with irritating effects.

Shaving soap.

Shaving Soaps are a class distinct from either of the foregoing. They are required not only to furnish a rich lather, but also that the latter shall remain on the face for some time without drying; they shall soften the beard without attacking the skin; they must have no unpleasant smell, and yet but little perfume must be used in them. These soaps will be specially described in succeeding pages.

Use of textile soaps.

Textile Soaps. Woolen manufacturers, wool washers, worsted spinners, silk dyers, calico printers, etc., use considerable quantities of soap, especially for scouring and fulling purposes Raw wool is cleansed of grease and dirt by washing, potash soap being

almost universally conceded to answer best for this purpose; it is then treated with oil in order to bring it into condition for spinning into yarn which is then woven into cloth. The cloth is then again washed or "scoured" in order to remove the oil used in spinning; for this soda or potash soap is used. The fulling process consists in spreading soap over the cloth and subjecting the latter to friction, thereby entwining the fibres of the wool in a manner which thickens the cloth; at the same time the cloth is cleaned by this operation. The soap in this case acts as a lubricant.

Requirements of textile soaps.

Considering the various uses for which soap is employed in woolen mills and other textile manufactories, and the various degrees of care bestowed on the work by the men entrusted with the same, together with prejudice and ignorance, it is not surprising to find that it is by no means agreed what constitutes good soaps for the textile industries. What the soap maker must do therefore, is to furnish the kind of soap which is demanded, and leave it to his customers to decide what they want. Yet it is well for the manufacturer to be familiar with the action of different soaps in the treatment of cloth, so that he may know where the blame belongs when his product should meet with complaint from the consumer.

At the outset it must be understood that really every good soap, *thoroughly saponified*, may be used in textile manufacture, and even cold made soaps, filled with silicate, starch, etc., find customers, although actually hardly fit for such uses. Some manufacturers require a perfectly neutral soap; but more frequently one that is strongly alkaline is preferred. For ordinary woolen goods that have not been dyed a somewhat alkaline soap is quite suitable, but most colors are readily dimmed by free alkali. The natural color of wool is bleached slightly by potash soaps, while soda soap—unless very carefully used—is apt to turn it yellowish. A too strong soap, whether made of soda or potash, will destroy the fibres of the cloth more or less, and a very strong lye would dissolve it altogether.

Properties of olive oil soap.

A neutral olive oil soap, made with soda, is the best textile soap known, which really contradicts the very common assertion that potash soaps are superior to soda soaps under all circumstances. The properties placing it ahead of all soaps are useful to remember: It is easily soluble, whereby specks of undissolved soap are avoided which are very troublesome when they get into the cloth. (To secure an evenly soluble soap from other

fats, 5 to 10 per cent. of weak lye are often crutched in.) Then a solution of olive oil soap remains thin and clear on cooling. This is important because the solution must in most cases be used at a low temperature, to prevent injury to the fabric, or "setting" of the dirt. (The greater solubility of potash soaps at a low temperature has no doubt done much to make them favorites in many woolen mills.) The greatest advantage of olive oil soap, however, lies in the proportions of olein, stearin, and palmitin contained in the oil, by which the soap has just the required solubility in water of a low temperature, and yet decomposes less readily into alkaline and acid soap, as described in a previous chapter. When this decomposition takes place the acid soap—which is insoluble in pure water, but soluble in the soap solution—is deposited on the fibres of the cloth during the subsequent rinsing, causing a rancid smell, uneven colors, and a tendency to catch dust. The same difficulty results when the soap contains free fatty acids.

Stock for textile soap.

The soaps made in this country for use in the textile manufacture are made either as bar soaps or as barrel soaps, the latter either with soda or with potash. The fats used are red oil, cotton seed oil, tallow, palm oil, grease, cotton seed foots, etc.

Tooth Soaps. Nothing is better adapted for cleaning the teeth than a pure, neutral soap. It is self evident that neither unsaponified fat nor free alkali is permissible in such soap; that the perfume must be selected with reference to its special use; and that in employing any special ingredients whatever, the object of the soap must always be taken into consideration.

Scouring Soap, Harness Soap, Medicated Soap, etc., are varieties which require consideration in a similar manner, as will be described in a later chapter.

The conditions being determined which govern the manufacture of a soap for its special purpose, the next question is:

IN WHAT FORM SHALL THE SOAP BE MADE?

Hard, soft and liquid soaps.

There are Hard Soaps, Soft Soaps, and Liquid Soaps.

Hard Soap is the result of combining fats and oils, or rather their fatty acids, with soda. In this form is most of the soap used in this country. As special forms of this kind may be mentioned *Chip Soap* and *Soap Powder.*

Soft Soap is made by saponifying the fatty matters with caustic potash lye. Although not used here nearly as much as in many

other countries, potash soaps have many advantages and deserve to be more widely employed here, for toilet purposes as well as for the laundry, and especially for washing woolens. Potash soaps are more easily soluble than soda soaps.

Liquid Soaps are solutions of soap in alcohol, water, glycerine, etc., put up in fancy forms, for cosmetic or medicinal purposes.

THE QUALITY OF THE SOAP TO BE MADE.

From a really first-class soap to a worthless article there are innumerable intermediate grades, depending on the ingredients employed, and on the care and knowledge applied to the work of compounding them.

As in every manufacturing business, the quality of originally good articles has frequently been debased in course of time by the pressure of a demand for cheapness. To discuss the ethics of this question would lead us too far from the purpose of this treatise, which is principally technical, and we confine ourselves here to the technical points involved. (See also Chapter IV.)

Cheapening soap.

Taking a pure tallow-soda soap as the starting point, we may cheapen such an article by substituting grease for the tallow. Such soap is somewhat softer and but little cheaper than a tallow soap, if a good quality of grease is used. Its quality as a soap compares with that of tallow soap, according to the quality of the grease. On the other hand, the tallow may be partly substituted by rosin; this serves a useful purpose, as said before, besides reducing the cost of the soap. But, the more rosin is used, the softer will be the soap; there is, therefore, a point where a greater proportion of rosin begins to positively impair the quality of the product; just where that point is every one may determine for himself, according to his judgment. Silicate of soda (a compound containing slight detergent properties), sal soda, talc, starch, silex, and mineral soap stock, cheapen such soap, when added either for special purposes or merely for the sake of cheapening it. In cocoanut oil soaps, salt and water allow of an enormous increase, besides that by the before-mentioned fillers, so that the manufacturer can sell at a very low price, provided he has *carte blanche* as to quality. (The effect of these various additions is further explained on other pages of this book.)

SPECIAL PROPERTIES OF THE SOAPS.

Floating Soap. This consists of a hard soap into which air bubbles have been incorporated while the soap is still hot. These

air bubbles are so small as to be almost invisible, and so numerous that they largely increase the surface of soap exposed to the water when the same is in use. Naturally such soap is more quickly soluble than the same article would be if it were not made to float, and regard to this fact should be had in determining on the materials and process for making this variety.

Transparent soap. Transparency is a property which conveys to the average buyer the impression of purity, although as a fact a perfectly pure soap is, under ordinary circumstances, no more transparent than is pure tallow or pure butter. By dissolving it in alcohol and subsequently evaporating the latter, soap may be made transparent. The same result may be, and generally is, brought about by the addition of glycerine and sugar dissolved in water, with or without the further addition of alcohol. Alcohol and the process of recovering it being expensive and troublesome, transparent soaps are mostly made by the addition of much syrup, less glycerine, and as little alcohol, if any, as possible under the circumstances. The glycerine in such soaps is, perhaps, a desirable feature, although it causes the soap to attract moisture and become wet on the surface in certain weather. The use of some castor oil with the other fats tends to cause transparency and to improve the texture of the soap, but it slightly reduces its lathering qualities.

Hard Water Soap. Water containing in solution such compounds as carbonate of lime and magnesia, sulphates of the same, or ordinary salt (sea water), is not well adapted for washing, as salt water is incapable of dissolving ordinary soap, while the lime and magnesia compounds present in most hard waters decompose the soap with the formation of insoluble lime and magnesia soaps. With such water cocoanut oil soap is the only one capable of doing effective work. (Palmnut oil soap is similar to the latter, but not made to any extent in this country.) For slightly hard water rosin soap, or soap containing a small excess of alkali, are somewhat better adapted than that containing no rosin.

"Boiled Down" Soap. Soaps that have been boiled and "settled," as will be described hereafter, contain a proportion of water more or less great, according to circumstances. The more water a soap contains, other things being equal, the more readily is it soluble, the faster will it wash, and the more of it is wasted in use. Where an economical soap is preferred to one that washes rapidly, or where the raw material used naturally furnishes a soft product, the soap is boiled down so as to reduce the proportion of water.

Such soap, during the process of boiling down, and through the consequent loss of water, becomes of a peculiar consistency which does not permit the coloring matter and other impurities present to settle to the bottom; these, therefore, remain in the body of the mass, and, by a process of crystallization in the hot soap, become distributed throughout the mass in vein-like formations, producing the "mottle" or "marble" peculiar to boiled down soaps. (If boiled down too far the mottle will not form, however.) This marbled appearance was formerly taken as a guarantee that the soap contained but little water, and has therefore come to be more or less successfully imitated artificially in soaps containing much water. By the loss of water during the boiling down the soap is also hardened, and where oils are used which naturally form a rather soft or easily soluble soap, such as cotton seed oil and red oil, boiling down is often employed. In the case of cotton seed oil boiling down also has the additional advantage of preventing the yellow spots already referred to. Ordinarily the soaps made in this country are nearly all settled soap, so far as they are at all made by boiling.

Artificial mottle.

A peculiarity of boiled down soaps is that they "sweat," *i. e.* attract moisture in damp weather, owing to the presence of foreign salts derived from the liquid on which they are boiled down.

BY WHAT PROCESS SHALL THE SOAP BE MADE?

The size and facilities of the factory, the prices of its products, and the quality and appearance of the same, demand several methods to be employed in different cases.

Advantages of the cold process.

The "Cold Process." The easiest manner of making soap consists in simply mixing the melted fat with strong caustic lye until a thick mass results which at first becomes heated spontaneously by the chemical reaction taking place; upon cooling in the frame in the course of a few days the soap is ready. The advantages of this "cold process" consist in the first place in simplicity and a fine appearance of the finished article while the soap is fresh. The glycerine formed in the process of saponification of course remains in the soap (as does in fact everything that goes into the mixer). Very small quantities may be conveniently made by this process, and at a comparatively small expense in time and labor. The disadvantages of the process are, however, quite important. It is practically impossible to make the soap as perfectly that more or less free alkali and free fat do not remain uncombined and mixed

Disadvantages of the cold process.

in the soap, causing harshness by the free alkali, and rancidity after a time and other bad features, on account of the free fat; the quantity of lye required to saponify a given amount of fat cannot even be calculated exactly in practice, as both fats and lye vary in composition; but even with an excess of lye used the presence of uncombined fat cannot be avoided. Moreover the fats require to be previously clarified carefully. Fats containing free fatty acids are entirely unsuitable for the cold process. (For further particulars see Chapter XIII.)

Advantages of "half boiling."

The "Half Boiling" Process. This is a method of making soap at a higher temperature than is employed for cold-made soap, but without actually boiling. It yields soap similar to that made by the cold process, but permits of somewhat more thorough saponification (and also, incidentally, of the addition of considerably more "filling" matter).

The Boiling Process. Although this is the process by which soap was made in the olden times, it is still the best method at this day, notwithstanding the many attempts to improve upon it. Only the use of steam instead of an open fire, and the use of ready-made caustic alkali instead of leaching carbonates with lime in the soap factory, are to be recorded as essential departures from the primitive methods of the ancients; but open fire is still largely employed in other countries, while the causticizing of carbonates by the soap maker is even now practiced in this country to some extent.

Advantages of the boiling process.

For making soap, and especially when large quantities or the best qualities are to be made, nothing can be simpler than boiling the fats with caustic lye, for the following reasons: The object to be attained is to bring every particle of fat in intimate contact with lye; it is therefore the first requisite that the fats should be melted, in order to acquire the necessary fluidity. Next, the fat and lye must be very thoroughly mixed with each other, which can in no way be done more effectively or more cheaply than by increasing the heat—required anyway—to the boiling point. The boiling can be continued as long as desired, so that the soap maker has perfect control over the operation; this he cannot have in the cold process, and the result is that only by boiling every trace of fat can be saponified. Then, again, it is only by various operations made possible by boiling that the glycerine formed in the course of saponification, the excess of lye, and numerous impurities contained in the fats and in the lye can be removed; the consequence of this

Boiling necessary for perfect saponification.

is that well boiled soaps, made neutral and freed from foreign matter, wash away less rapidly than cold-made or half-boiled soaps, and do not become rancid in time by the presence of free fat.

Division of boiled soaps.

The boiled soaps, as usually made in this country, may be divided into two classes: "Settled" and "Boiled Down" soaps, besides the "Run" soaps, which are hardly made any more, however, at the present time. The settled soaps, which are those produced in the greatest quantities, are made by allowing the hot soap, while rather thin, to settle in the kettle, so that the impurities, the foreign salts, and the excess of lye and water, together with some of the soap, form a dark precipitate called "nigre," from which the pure soap is drawn off. Such soaps contain a greater proportion of water than "boiled down" soaps, which have already been briefly described on page 143. "Run" soaps were made by simply saponifying the fat by boiling with lye, and framing the mass obtained with such liberal allowance of water and filling as was desired.

Advantages of milling.

Milled Soap. The mechanical process of milling has for its object the forming of cakes of soap which will not shrink with age, retain a fine appearance, an even texture, and are finely perfumed while the soap is cold, so that a minimum of perfume only is lost by evaporation. Milled soaps contain only a small percentage of water, as they must be thoroughly dried before being treated by the machinery described on the preceding pages, and they consequently preserve their original shape indefinitely. A well dried, neutral, boiled soap may be mixed with colors and perfumed and be worked into the finest and best articles for toilet purposes. By this process, however, cold made soaps are frequently milled also, in order to take advantage of the popular favor in which milled soaps are held, although in this case milling is of little practical benefit to the soap, except perhaps in so much as it becomes a little milder by being exposed to the air and by the repeated handling. An ordinary cold made soap is amorphous in structure, while milled soap shows a grainy or fibrous formation, in consequence of which the ends of the cakes, after pressing, have a different appearance than the cakes of either cold made or ordinary boiled soap. At present the milling process is confined to the manufacture of toilet soap, but in view of the constantly improving character of laundry soaps, and the improved machinery likely to become popular some time in

Cold made soap for milling.

the future, it would not seem improbable that milled laundry soap is yet among the possibilities.

REMELTED SOAP.

For making toilet soap from stock soaps, but more often for working up scraps of soap without boiling them over, remelting may be resorted to. For the manufacture of toilet soap the process of remelting is mostly confined to England, where the soap manufacturer furnishes a well boiled soap to the perfumer, who colors, perfumes and works it over into cakes of toilet soap by remelting. In this country toilet soap is generally made by milling or by the cold and half boiling process. But for working over the scraps of soap, remelting is the most convenient and economical way. The cold process permits of hardly any other convenient means of utilizing scraps, while the reboiling of scraps would cause the loss of the filling which would go into the waste lye, and of the perfume.

CHAPTER VII.

Settled Soaps.

The settled soaps are those made, briefly stated, by boiling the fats, oils, and rosin with lye until thoroughly saponified, separating and drawing off the waste lye, "strengthening" and washing with a change of lye, and subsequently thinning the soap out with water, whereby the excess of alkali and other impurities are settled to the bottom of the kettle, as more fully described hereafter. The last mentioned operation is technically termed "pitching" or "settling." This is the most—not to say the only—practical process for making a thoroughly saponified and at the same time perfectly neutral piece of soap. Even a soap that has been boiled down without previously settling it (as process by which, for instance, the true Marbled Castile is made) always contains some free caustic alkali. Definition of settled soaps.

The settled soaps may be conveniently divided into those containing rosin (yellow soaps), and those not containing it (mostly white soaps). We will first describe the former.

ROSIN SOAP.

The settled rosin soaps are made either of tallow and rosin, or grease, stearin, palm oil, cocoanut oil, cotton seed oil, etc., may be substituted in place of part or all of the tallow. Selection of stock.

For soaps containing a large proportion of rosin, fats rich in stearin are best suited, while the softer fats and oils are more suitable for soap in which little or no rosin is employed. This adaptability of the different fats rests on the solid consistency and comparatively small solubility of the soap formed by the combination of stearin and soda. Rosin softens such soap and makes it more soluble. On the other hand, the softer fats and oils, containing less stearin, form soaps which are *naturally* soft and easily solu-

ble; they are consequently adapted for use in connection with much rosin only when a "boiled down" soap is to be made, in which case the decrease in the quantity of water present counteracts the softening effect of the rosin.

Cocoanut oil, used together with other fats in a rosin soap, increases the solubility still further, but the soap will be harder than a tallow-rosin soap that had been made equally soluble by the use of a large proportion of rosin. It will also lather more freely.

The better grades of settled rosin soap are made of fats and rosin in the proportion of about 35 lbs. of the latter to 100 lbs. of fat, and mostly with the addition (in the crutcher) of about 6 to 8 per cent. of a strong solution of carbonate of soda to the finished soap, for the purpose of hardening it and increasing its detergent properties.

Cheaper varieties are made by using ordinary grease in place of the tallow or the other fats and oils used; also by increasing the proportion of rosin (up to 100 per cent and more of the fat used), and by "filling" with silicate of soda, talc, silex, mineral soap stock, etc.

Taking a soap of tallow and 35 per cent. rosin as the basis for a description, the process of manufacture is conducted as follows:

SAPONIFICATION OF THE FAT.

Settling or clarifying the stock. The clear fat is drawn from the settling tank into the clean kettle; or, in the absence of a settling tank, and if there is no "nigre" in the kettle, the tallow is run into the latter as it is melted out of the barrels, and clarified by boiling it on water to which some salt and some alum have been added. The dirty water is then run away after a short rest. The use of a settling tank is always to be recommended, as it will permit of examining the fat for adulterations, many of which settle out while at rest; and also because the clarification by boiling on salt water can be conducted in it, while the kettle is otherwise occupied. It will also be well to take notice of the amount of lye absorbed by the fat, and should a certain lot of fat use noticeably less lye than usual it will be advisable to examine it for unsaponifiable admixtures.

The salt has no other effect in this operation of clarifying than to cause the dirty water to settle rapidly after boiling, in consequence of the increased gravity communicated to it by the dissolved salt. When the water has been drawn off, the clear fat is ready for

saponification in the same manner as if it had been drawn from the settling tank.

Alum may be used, together with the salt, to remove gluey impurities contained in much of the greases and tallow found in the market.

The same preliminary treatment of the fats is indicated when lard, stearin, grease, cocoanut oil, &c., are to be clarified; many impurities are thereby removed which it is difficult, or even quite impossible, to eliminate from the mass after saponification.

Another method of clarifying.

A different method of clarification consists in using strong lye instead of salt water, and only working the contents well through with steam, without heating more than necessary to accomplish this; then applying just enough steam to separate the dirty lye well from the fats, and drawing it off.

The clear fat is next saponified, or "killed," as it is termed, by running lye into the kettle and turning on open steam, or both the open and closed steam. "Tallow," it used to be said when our commercial caustic was not of as high grade as it may now be had, "requires weak lye at first, as it combines with strong lye only after it has been already partly saponified." The lye was, therefore, run in at a strength of 8 to 10°B. at first.

But this behavioı was due to the foreign salts in the caustic, and if the lye is made by dissolving caustic soda of high grade in water, it might be used much stronger from the start, and would still combine with the tallow; only the resulting mass would be too thick to boil freely; so weaker lye is either used, or stronger lye and water are run into the kettle together.

Strength of lye to begin saponification.

Cocoanut oil combines readily with strong lye. and in doing so draws the tallow into the combination if both are saponified together. If, therefore, the fat consists of both, tallow and cocoanut oil mixed, instead of tallow alone, the lye—even if made from the lower grades of caustic—may be used stronger from the beginning in the ratio as the proportion of cocoanut oil to tallow is larger. Palm oil, stearin, and grease are similar to tallow in this respect; cocoanut oil only finds a counterpart in palmnut oil and in free fatty acids.

Too weak lye only adds unnecessary water to the boil and retards the chemical combination. When, on the other hand, the lye used is made of low grade (say 60%) caustic and applied too strong at any stage of the saponification, the partly formed soap is unable to remain dissolved in it; it then coagulates or "opens"

(so that the lye can be observed to separate from a sample taken on the paddle or trowel) thereby preventing the proper action of the lye on all the particles of fat. If this condition should set in at any time during this operation, weaker lye must be added until the mass "closes" again. But if the lye was made of high grade (say 70%) caustic, then the soap will either not open at all, or close by itself after a few minutes' boiling, should the lye be too strong at any time.

The lye used in this operation may be made by dissolving in water caustic of 60% or of 70%, or of any other grade desired, according as convenience of working and cost of the caustic may dictate. The action of lye of different grades in this respect has been explained above, and also on pages 64-67, and we need therefore merely repeat more especially that the carbonate of soda in all lower grades of caustic does not combine with neutral fats, and will therefore be lost by running away the waste lye afterwards, unless precautions are taken to absorb it previously to running away the waste lye, by the addition of some free fatty acid, or rosin. This utilization of the carbonate can only be effected, however, when there is no more *caustic* alkali present in the kettle, as otherwise the rosin or free fatty acids would combine with the latter in preference to the carbonate.

Utilizing the carbonate.

The lye is run into the kettle in a steady stream, and under constant boiling. The presence at any time of a large surplus of lye in the kettle only retards the process of saponification, but a lack of lye at any time must also be guarded against, as it would cause "bunching" (a thickening up of the partly formed soap). The lye is therefore added only about as fast as the fat is able to absorb it, and not fast enough to disturb the even ebullition of the mass.

"Bunching."

When working with a large kettle, in which "bunching" would be especially troublesome, requiring hours of work and boiling to overcome, it is advisable to run in lye and fat together from the start, thereby saving time and reducing the risk of bunching at the same time. This is especially necessary if the fats contain free fatty acids in large proportion, which combine very quickly with lye, and are thus particularly liable to cause the trouble mentioned.

Should bunching of the soap take place, very strong lye or salt water must be run in, the steam turned on full, and the contents well worked through until they are brought back to the nor-

mal state. In the case of a small kettle this process may be assisted by vigorous crutching.

To regulate the strength of lye, strong lye and water may be run in together, gradually decreasing the proportion of water. (A convenient arrangement for this purpose may be found under the description of the lye tank, on page 80.)

Use of open and closed steam.

The saponification or "killing" of the grease is most advantageously performed by boiling slowly with open steam, which, by the pressure with which it issues from the perforated pipe, causes a brisk movement in the contents of the kettle. When the kettle has both open and closed steam, satisfactory results may be obtained by using both; when boiling with closed steam great care is necessary, however, as the steam pipe remains hot for some time after shutting off the steam, and a boiling over might be impossible to prevent if once started with a hot closed coil.

The heat developed spontaneously by the combination of the materials taking place is often sufficient to cause boiling over even when all steam has been shut off; it is therefore often advisable to have water or salt water handy to sprinkle over the soap in case of necessity. In all operations of boiling it must be remembered that the open steam *adds* its condensing water to the mass and causes a strong agitation in the contents of the kettle; the closed steam, on the other hand, causes a slower, even ebullition, and *removes* water from the kettle by evaporation.

End of first change.

This operation of saponifying the fat (also called "First Change") is considered complete when the soap formed will not absorb any more lye, and, after boiling for a reasonable time without the addition of more lye, indicates by the peculiar "sharp" alkaline taste that the last lye added remains uncombined in the kettle (the soap has surplus strength). At this stage the mass begins to be clear; a small sample taken on a piece of glass is transparent and remains so until it cools off. Pressed between the fingers it should have a good body and not be smeary; a sample taken on the thumb and pressed in the palm of the hand by sliding the thumb over it, must curl into a rather dry shaving.

When the proper signs mentioned are absent, although the soap has a sharp taste, it indicates the presence of unsaponified fat, owing to the lye used having been too strong, so that it could not act properly on the fat. The addition of weak lye, or even water, or boiling a little longer, will then be required to cause the soap to absorb more lye.

Quantity of lye required.

The total quantity of lye required for the saponification is roughly estimated at 100 lbs. lye of 20° B. to every 100 lbs. of stock. Cocoanut oil requires a little more lye than ordinary fats. The exact quantity of lye necessary for saponifying a fat is not required to be calculated in making soap by boiling, and is therefore made the subject of some special remarks in another chapter of this treatise.

Saponification not yet complete.

It is a not uncommon error to believe that when the soap shows some sharpness after the boiling has continued for a few minutes without the addition of more lye, the fat must be perfectly saponified. This assumption, however, is often far from the truth, for even after the soap has been again boiled on fresh lye, it very frequently still contains unsaponified fat. Indeed, many—not to say most—ordinary soaps on the market contain free fat from this cause. A thorough saponification is only effected by prolonged boiling with sufficient lye of proper strength to permit combination.

Graining the soap

When the saponification has proceeded until the before mentioned signs indicate that the soap has been well formed, the next step is to remove from it the waste lye, that is to say the superfluous water, the foreign salts that were contained in the lye, (notably carbonate of soda) and the glycerine formed during the process of saponification. This removal is effected by adding salt, or salt soaked in water, or—better yet—a saturated solution of the same in water, or strong lye (30 to 40° B.) to the boiling mass.

The waste lye, on taking up the salt, or the excess of caustic, as the case may be, becomes unable to hold the soap in solution, and at the same time it withdraws water from the soap; as a consequence the latter rises to the top of the mass in the kettle, and the waste lye with the dissolved salt, glycerine and various impurities settles to the bottom. About 6 to 8 per cent. of salt (calculated on the weight of fat used) is required for this purpose, the quantity depending on the amount of superfluous water present and on the kind of fats used.

A pure tallow soap will thus be separated from the waste lye when the latter contains enough salt to indicate 12 to 14 °B. on the hydrometer. Cocoanut oil soap remains soluble in the waste lye until the latter is raised by salt to above 24–26° B.

If salt is used it is preferably dissolved in water before adding it, as some of it is otherwise liable to remain undissolved in the soap and cause trouble afterwards. This is especially so if the

soap is of a tough consistency, such as results when a good tallow is boiled with strong lye made from high grade caustic; in such cases, when dry salt was used in the first change, it has even happened that it was found still undissolved in the finished soap in the frames.

The soap, boiling well while receiving this addition, will "open," that is to say, it will coagulate slightly, and the lye separates from a sample taken on the paddle. When it is observed that the soap begins to open, no more salt or brine is required; the open steam is turned off, and boiling is continued on closed steam only, until by evaporation the soap is deprived of enough water, and the waste lye has become concentrated so far, that it separates clear and thin from a sample of soap taken on the paddle (or trowel used in its place in some factories). The closed steam is then also turned off, and the soap is allowed to rest for say four or five hours, in order to let the waste lye settle.

The use of lye instead of salt for graining.

The effect of the salt or brine here described may also be brought about, as stated before, by using strong lye instead. Salt is ordinarily used merely for the sake of economy, as the waste lye is charged with many impurities, and therefore run away without further use (unless worked up for the recovery of glycerine). But the use of strong lye has the advantage of keeping the soap free from salt, which but too often causes soap to be "cracky" in the frames, unless it has been very thoroughly removed in pitching. When lye is used instead of salt the alkaline strength it contains may afterwards be utilized in making a lower grade of soap.

Cocoanut oil soap is difficult to grain on salt, of which a large quantity would be required to separate it from the waste lye; consequently, when a large proportion of cocoanut oil is saponified together with other fats, a different method of working is generally adopted, as will be explained hereafter.

It sometimes occurs—with the use of stock of poor quality—that the soap refuses to open on the addition of salt. This may then be remedied by allowing it to cool off somewhat, and if it should thereafter become weak in alkali, adding a little more lye, when it will generally separate without further trouble. It may be advisable to assist the process in this case by means of crutching. (See also under "Grease," page 44, on this subject). Sometimes soap will not open on dry salt for the reason that water is lacking to dissolve it, in which case brine is necessary for the purpose. Some soaps naturally appear thin (cotton seed oil soap, for instance)

even if they contain but little water, so that brine may sometimes be necessary, instead of salt, notwithstanding the fact that the soap has a thin appearance.

Saving the soap from the waste lye.

The waste lye, after sufficient rest, is drawn off into a tank in which it is allowed to cool, before running it away. Any soap which it may have held in solution while still hot will then separate and may be regained, whereupon the clear waste lye is run away (or worked up for glycerine). A dirty precipitate will collect on the bottom of this tank, and must be removed from time to time, as it is of no value. This is most easily effected by connecting the tank with the steam boiler whenever the latter is "blown off," letting the hot water from the boiler run through the tank, thus washing away the precipitate which is quite difficult to remove in any other manner.

THE ROSIN CHANGE.

The waste lye having been drawn off, the rosin is next saponified by boiling it, together with the soap, on additional lye. Fresh lye is first run into the kettle, at a strength of from 18 to 20° B., and in sufficient quantity to at least stand high enough in the kettle to cover the closed steam pipe, in order to prevent as much as possible the sticking of the rosin to the hot pipes. Both open and closed steam are then turned on and, after boiling the soap alone for a short time, till it forms a somewhat grainy mass, the rosin is shoveled in.

The lye is used at say 18° B. because at this strength it combines readily with rosin. Weaker lye would be apt to cause frothing of the soap, would be a waste of kettle room, and would interfere with the free working of the contents, as during the saponification of the rosin the soap must be kept "open" by having an excess of sufficiently strong lye in the kettle at first, and towards the end of the operation by adding salt.

The closed steam is used during this change to promote an even, regular boiling; the open steam serves to keep the rosin from the closed coil.

The rosin used may be of light or dark color, according to the grade selected. Of course the darker the rosin used, the more highly will it color the soap, as only part of the coloring matter can be removed by boiling on lye and subsequent settling.

The rosin combines almost instantly with the lye, which must be continually run in (at the strength above mentioned) while

the rosin is added, so as to keep the soap open by the excess of strong lye always present in the first stages of this change. When nearly all the rosin has been shoveled in, the supply of lye is cut off, and some salt or brine is added into the kettle to keep the soap open, while the last strength of lye is absorbed by adding the remainder of the rosin.

The object of having the soap open on the rosin change is twofold. In the first place, it promotes easy working in the kettles and prevents the rosin from going to the bottom too readily; secondly, it helps to discharge more of the coloring matter of the rosin. The combination of the rosin (unlike that of neutral fats) with the lye is not in the least disturbed or retarded when the soap is open.

All the rosin having been added and saponified, the soap being open on salt, and when the lye runs thin and clear from a sample on a trowel, the steam is turned off and the soap allowed to rest for about five or six hours, to settle the waste lye. As the latter is run away it should have no caustic strength, or at least but very little; a slight sharpness here aids to discharge more of the color of the soap, as does also the presence of some carbonate of soda in the lye. When the lye is well separated, draw it off and run it into a tank as before, to regain the soap which it holds in solution while hot. After cooling in this tank the soap is taken off and the clear lye is then run away.

A simplified process.

[For a simplified process of making this soap, strong lye at 20° to 25° B. may be used instead of salt to keep the soap open as described above. This lye, after separating by rest, is then saved for the strength it contains, and the soap is thinned by boiling on a little water and open steam, and "settled," as described hereafter. Made in this way, the soap is darker and the fat less thoroughly saponified than when the more elaborate process, as here described, is employed.]

STRENGTHENING CHANGE.

The waste lye from the rosin change being run off, the soap is boiled again on lye, in order to saponify the last particles of fat and rosin still present and to wash out as much of the remaining color, salt, and other impurities as possible. The salt, especially, must be removed, as its presence disturbs the operation of settling, and later on also the framing. This process, called "strengthening," may be carried out as follows:

Weak lye, of say 6-10° B. (according to contents of water still in the soap and to steam used, closed or open), is run into the kettle, enough to cover, as before, the steam coils, so that boiling may proceed quietly, and that the rosin which may still adhere to the coil may be saponified. Closed steam is turned on, and the soap boiled slowly. As the alkaline strength is absorbed more lye of the same strength is added, and occasionally the open steam turned on for a few minutes to work the contents of the kettle through, and to remove any rosin which might still adhere to the coil. Enough lye must be added to give the soap good sharpness and to cause it to open to a very soft and large grain, in which condition it drops the impurities and is most easily drawn together with water afterwards. If grained too far, by too strong lye or by too prolonged boiling, much water is required later in finishing, causing an excessively large "nigre" and trouble in framing, as will be more fully described in the succeeding pages. When opened, as stated, the materials should have become well saponified, and a sample, when pressed between the fingers, forms comparatively dry scales which must not be smeary. Steam is turned off and the lye given time to settle. After sufficient rest the lye—which may even be weak enough to have a little soap dissolved in it without detriment, especially when very dark colored stock has been used—is drawn off and saved for its strength which it still contains. On cooling, any soap that it may have held in solution may also be regained.

An extra change. A different proceeding may be adopted, instead of the strengthening change here described, by first making an extra change in the following manner:

The waste lye from the rosin change being drawn off, open steam is turned on and weak lye, or even water, run into the kettle. Boiling and the addition of weak lye are continued until the soap becomes close and thin, and tastes slightly sharp. Then it is grained by the addition of brine, and boiled on close steam until a good curd is formed. Then, after sufficient rest, the waste lye is run away and the soap closed again by the addition of water, under constant boiling, until it is clear and smooth. Lye of 10 to 15° B. is then run in and boiling continued, on both open and closed steam, till the soap opens again and the lye begins to separate from the soap. Boiling is then continued on closed steam alone, till the soap forms a soft, round curd, and the froth formed at first begins

to disappear. After resting for some hours the lye is drawn off and saved, as already described.

"FINISHING" OR "SETTLING."

This operation, also known as "pitching" or "fitting," progresses most favorably in large batches, as it depends greatly on the length of time during which the soap retains its heat. The object is to remove the free alkali, water, salt and other impurities that still remain, such as the insoluble soaps formed by the combination of small portions of the fat with various impurities of the alkali, as lime, iron, etc. It is carried out as follows:

The lye from the strengthening change being drawn off, the open steam is turned on slowly to warm the soap, and a little water is then run into the kettle. Boiling is thus continued with open steam, or with both open and closed steam, until the soap is quite tough and "close," and a sample slides from the paddle, held slanting, in large flakes, which adhere tenaciously to the paddle, so that on dropping from the latter the part still adhering draws back like an elastic band. The soap in the kettle must look bright and shiny, and should have but little sharpness. It will rise in the kettle and should be made to swell up as high as possible, which will facilitate the dropping of the "nigre."

Only so much water must at first be added that the soap does not assume the appearance here described too quickly, so that the water may be well boiled through before the operation is finished, and may be distributed evenly throughout the mass.

If at the beginning of the operation it should be found that the soap thickens, it is either lacking in water and then will be sharp in taste, or it is weak in consequence of a deficient supply of lye. Accordingly water or weak lye must then at once be added.

When the soap has been raised as high in the kettle as possible the latter is covered up to keep in the heat, and the closed steam is turned on for half an hour longer, when it is also turned off. The soap is now allowed to rest for a day (when it may be uncovered if the weather is warm, to cool off more rapidly if the saving of time is an object), or it remains covered to settle as long as possible. According to the size of the the kettle and its construction, and to the weather, the cooling will require from two days to a week. The more time can be allowed for settling the more thoroughly can the operation be carried out.

GENERAL REMARKS.

Simplified methods.

In the foregoing pages has been described the most usual process for boiling settled rosin soap; but different plans are sometimes adopted to suit different circumstances. For instance, the rosin may be added at once when the tallow has been saponified, without first graining on salt. Or, on the rosin change, the soap may be kept open on alkaline strength at first, without using salt for the purpose, and finally enough rosin added carefully to take up nearly all this strength, so that the soap boils in a close condition similar to that in the finishing boil already described. It may then be settled at once, without a separate strengthening change, and the boiling is thus simplified, but, of course, at the expense of the quality of the product.

Another simplified process consists in boiling fat and rosin together on brine, in order to discharge as much of the color as possible, and then saponifying with lye at from 15—25° B., so that a little sharpness is left at the end of the operation. In this condition the soap is left to settle.

Or again, the fat and rosin may be saponified with just enough lye to make the soap perfectly neutral, cooled as if for settling, and framed in the ordinary manner. (This would of course not be a "settled" soap.)

Several other varieties of these simplified processes might be mentioned, but since they naturally do not produce as thoroughly saponified and clean soap as is made by the more extended method described in the preceding pages, it is not necessary to go into further details on this line.

As has been said before, rosin combines readily with carbonated lye; it seems, however, that the soap formed in doing so is softer than that made with caustic lye, and the carbonic acid set free during saponification throughout the mass is a great inconvenience.

FRAMING.

When the soap in the kettle has become cooled down to about 140° F. in warm weather, or 150° F. if the weather is cold, framing of the clear soap may be begun.

At the bottom of the kettle will be found a dark colored soaplike mass, called the "nigre," which amounts to about one quarter—more or less—of the whole. Above this is found the clear soap. (The utilization of the nigre will be treated on hereafter.)

The clear soap, if run hot into the frames without filling, and left there to cool, will solidify in wave-like formations, causing an appearance not unlike the grain of wood, which they resemble also in that the bars of soap warp slightly in the direction of the waves on drying. The cause of this is the crystallization of the soap formed by the stearin and soda, from the olein soap. The soap framed in this manner would, however, remain soft until it dries considerably, and for the purpose of hardening, as well as to prevent it from warping too much on drying, and to increase its detergent properties, a strong solution of carbonate of soda in water is crutched into the soap before running it into the frames. In England, where a perfectly neutral soap for all purposes is made so much of (and to a small extent also in this country) the clear soap is framed without any addition and known there as "Primrose" soap. **Unfilled soap.**

The framing of the soap is generally done as follows:

The carbonate of soda required is melted, either sal soda or soda ash being employed. Sal soda is melted by the application of open and closed steam, to be of a strength of 33-34° B. while hot (which will be equal to 34-36° when cold). If it is to be used cold it should be melted the evening before, so as to let the sediment settle over night and cool off. Instead of sal soda, which was formerly the purest commercial form of alkali, many factories now use a very pure grade of soda ash, or what is known as "58% pure alkali," of which a sufficient quantity is dissolved in enough water to be of the desired strength, as above. **Sal soda filling.** **Soda ash.**

The clear soap is pumped out of the kettle into a vessel which is somewhat larger than the crutcher, and placed directly above the latter, so that the soap will run from it into the crutcher by its own weight on opening the valve. The object of this vessel is to permit of continuous pumping while one frame of soap is being crutched, whereby not only time is saved, but the danger of the soap setting in the pipes and choking them is also averted. When soap enough to nearly fill the frame has been run into the crutcher, the machine is started up, and from 6 to 9% of the soda solution added at once. The crutcher must be sufficiently filled to prevent the soap from catching air as it falls over the rim of the inner cylinder, as otherwise it will become frothy. The soap at first thickens, but as the machine gradually runs faster and thoroughly mixes the contents, the soap becomes perfectly smooth and bright. The crutching for each frame does not require over five minutes, and **Manner of framing.**

as the soap cools off during this time, advantage is taken of this fact to add the perfume just long enough before running the soap into the frame to insure its thorough mixing; this avoids, as far as possible, the evaporation of the perfume. (See, also, the chapter on perfuming soaps). A sample taken out of the crutcher, when cooled off, must be quite solid, and on cutting with a knife it must not be smeary. A clean trowel sunk into the hot soap, until it becomes heated, and then withdrawn, must have the soap closely adhering to it and thus show that it is in a "close" condition. If these conditions are properly fulfilled, the soap is at once run into the frame and will be a good marketable product when cut and pressed; nor will it effloresce on aging.

The exact amount of soda solution which the soap will take without trouble may be determined by trying say 6 per cent. at first and crutching; if the soap assumes the smooth appearance, etc., described, the quantity added is sufficient, but if a sample taken out does not retain this appearance on cooling, then more must be added, till the soap, when cold, is satisfactory.

If the soap fails to thicken after the soda solution has been added, or to become perfectly smooth and close, but on the contrary opens, it is an indication that either the strengthening change or the thinning out in the kettle for settling was not properly managed. If the soap does not adhere to the hot trowel, but leaves the latter clean and bright, it indicates also that the soap is too short, i. e., has been separated, and is not in proper condition for framing. The only remedy in this case is to grain the whole boil again and make a new settle, for if framed in that condition it would drop part of the soda filling in the frame, be full of cracks, and become covered with efflorescence on drying. *Only soap which is very nearly or quite neutral can be filled properly*, and if the soap had been grained too far in the strengthening change, so that the lye could not settle out well, and too much water was required for thinning in consequence, the soap will not settle properly, will contain too much water, and will not be sufficiently neutral to take the filling readily.

Temperature in filling.

The proper temperature for framing is a matter of importance in this soap (as in most others), and should therefore be regulated by warming or heating the soda solution in the ratio as the soap remaining in the kettle cools off, while the first part is being framed. While the soap is still at about 140° F. (according to circumstances), the solution is used at about the same temperature, but with

too cold soap it may be necessary to heat the filling, even to boiling. If framed too hot, the soap will be cracky on drying. Soap containing much rosin, or much water, must be framed at a lower temperature than the soap here described, say at 130° F. If for any reason the soap arrives too hot in the crutcher, cold water is circulated in the steam jacket of the machine.

When the average temperature of the soap and soda solution together is too cold for framing, the mass will assume a dull appearance in the crutcher, remain soft, and is prone to become frothy by the action of the machine. The crutcher must then be stopped and covered, and steam admitted to the jacket until the mixture is warmed up properly. For the next frame the filling must then be heated.

Conditions governing amount of filling.

Regarding the amount of soda ash or sal soda to be used in framing, this has been stated above at 6 to 9 per cent. of the weight of the soap, which is the proportion generally used, and the mode of preparing it has also been described. However, these statements are subject to the following qualifications:

One reason why the correct proportion varies is that the soap may not have been finished perfectly neutral, or it may have retained some traces of salt. In these cases the soap will not take as much filling as a properly finished soap would stand without trouble.

Another thing to be considered is the quality of the carbonate of soda used in preparing the solution. It is obvious that it cannot be immaterial whether the carbonate is pure or otherwise. Some soda ash contains as high as 20 per cent. of foreign salts, while sal soda and 58 per cent. alkali are very much purer. The foreign salts do not have the same effect on the soap as the actual carbonate of soda, and more of the impure alkali would therefore be required to be the equivalent of the pure article. But on the other hand, the foreign salts in the lower grades of soda may act as a disturbing element (especially when framing rather warm), for they will naturally exert a similar influence in the soda solution as if they were present in the soap, and the consequence of this may very easily be cracky soap. The pure grades of alkali are therefore preferably employed in filling. (See App. Note 15.)

Evaporated sal soda.

When too much water is present (either from having thinned out the soap too far in the finishing boil, or because the soap had been grained too strongly in the previous change), part of the ordinary sal soda may be substituted by "evaporated" sal soda,

which is a carbonate having less water in its composition than is contained in the ordinary article. This "evaporated" carbonate attracts the superfluous moisture in the soap, and is used by stirring it dry into the hot sal soda solution. The amount of it to be used must be judged by the appearance of the soap in the crutcher. One pound of it is equivalent in alkali to 2½ lbs. of ordinary sal soda.

Starch. Soap containing much rosin, and therefore apt to be sticky, and to crack when filled with sal soda alone, may also be filled with a little starch in addition, which binds the materials together and absorbs much of the moisture, facilitating framing by preventing the separation of the materials. For a soap made of tallow and 75 % rosin, for instance, 9 to 10 % soda solution, to which 1½ to 2 % starch have been added, may be used to advantage. (See chapter on "Filling," under "Starch," page 73).

Soap made of part cocoanut oil, owing to its ability to absorb large quantities of salts without separating, will not become cracky so easily as a tallow-rosin soap.

Instead of sal soda or soda ash solution alone, with perhaps a little starch, many other additional filling materials may be employed for this kind of soaps, but as said before, they cause a more or less unsightly appearance of the soap on drying.

Different filling mixtures. For instance, silicate of soda at 35° B. may be added by crutching, from 2% upward, as the soap will stand it, and according as more or less sal soda is added.

About 2% silicate and 8% soda solution, to which 8% of talc may also have been added, are frequently used; or 8 to 10% sal soda and 5% of silicate.

Still another mixture: 100 lbs. sal soda (or an equivalent weight of soda ash), 10 lbs. borax, 10 lbs. pearl ash, dissolved together, to 38° to 40° B. Add 10 to 12 lbs. starch, and use from 6% to 8% or more of this mixture, according as the soap will take it.

Where no silicate or starch are used, silex is sometimes crutched in, although this material is certainly not to be recommended in a laundry soap, and it is not so much used now as formerly. The silex is first mixed with the warm sal soda before adding it to the soap in the crutcher.

For further particulars on filling see the chapter on these materials on pages 71-74.

STRIPPING, CUTTING, DRYING, ETC.

It requires from one to three days for the soap to solidify sufficiently so that it can be "stripped," that is to say the frame taken off, if iron frames are used. In wooden frames about a week is necessary. Another day is then allowed for further cooling, and then the soap is cut into slabs and bars by the machinery described heretofore.

The bars are stacked on racks for drying slightly, until a somewhat dry pellicle is formed on their surface.

The drying operation is still largely conducted by simply exposing the soap to the action of the atmosphere. This requires much room, and the drying proceeds in a hap-hazard way, according to the weather, but slowly at best. Some manufacturers heat their drying room by steam apparatus, to make the process at least positive.

The most rapid drying is secured by the fan apparatus described in chapter V., which also produces a glossy skin on the soap that facilitates pressing and improves its appearance.

The operation of pressing will be described in a separate chapter.

THE NIGRE.

The "nigre" is a mixture of soap, water, and various salts and impurities which are washed out and precipitated during the settling operation; there is also present the excess of alkali that was left in the kettle after drawing the strengthening lye, and coloring matter incidentally introduced with the various raw materials. **Nature of nigre.**

The formation of "nigre" in the kettle takes place as follows: The strengthening lye, it will be observed, was so strong when drawn off that it was unable to hold any soap (or at all events but very little) in solution. On diluting the remaining traces of this lye, however, as is done in the finishing change, its capacity for dissolving soap is proportionately increased, and in consequence there is formed a weak lye, holding in solution more or less soap and the salts, etc., already enumerated. This solution, being specifically heavier than pure soap, sinks to the bottom of the kettle, taking various impurities along in so doing, thereby clarifying the soap and constituting the "nigre."

It is evident from the explanation that the more water is used in thinning the soap the more soap will be dissolved, and the larger will be the nigre in proportion to the pure soap above it.

At the same time the pure soap also holds more water when the nigre is larger.

Rosin and soft greases form soap which is more soluble in water containing salts than is pure tallow soap, and olein soap is more soluble than that from stearin, so that the nigre if grained on salt will furnish a soap which has slightly more rosin and soft fatty acids in its composition and is therefore softer than the good soap in the kettle, besides being mixed with more coloring matter, with insoluble soaps formed by lime, iron, etc., and with impurities generally. Still, the proportion of good soap in the nigre is very large and must be utilized in some way.

The nigre will constitute about one-quarter of the contents of the kettle (more or less, according as the soap was settled coarsely or finely) and may be utilized in various different ways, of which those generally employed may be enumerated as follows:

Utilizing the nigre.

I. The nigre resulting from a batch of soap from fresh materials that were boiled in a clean kettle is left in the latter; fresh stock is added and lye run in until the stock is saponified; the boil is then finished as usual. The nigre which results from settling this batch is still softer and more impure than the first nigre, and is generally used, together with fresh stock (mostly of somewhat inferior quality) for a second quality of soap. This is repeated through several boils of second grade soap, when the nigre is finally used for a still lower quality of brown soap, in which common fats and a small proportion of palm oil (the latter for improving the color) may be used. The nigre again resulting from settling this dark soap is saved, until from successive similar batches enough of it accumulates to make a very low grade of soap from it.

II. The nigre, after passing through two or three batches of the best soap, is separated by adding salt and boiling. A frothy soap is thereby separated, from which the salt solution is run away after a sufficient rest. The soap so separated is saved in a kettle by itself (or in frames), and when enough of it is on hand to make a batch it is boiled on weak lye and again grained on salt. The waste lye is then settled and run away; the soap receives a somewhat coarse finish, is settled and then framed for occasional use in some lower grade of soap. The nigre resulting from this settling operation is set aside for use in a very dark grade.

III. The following plan will, in many cases, be found useful: The nigre is used first for the lighter colored soaps, then for the

darker ones, and when it finally becomes advisable to use it up, so as to be rid of it, it is grained, the waste lye run away, and the soap washed out by boiling with plenty of weak lye, at, say, 3-6° B., so as to remove all the salt. Then it is fitted to form a very thin grain, so that the lye is not quite clear, but contains just a trace of nigre, and time is allowed for settling. The soap so obtained contains an excess of alkaline strength, which is taken out by adding, in the crutcher, an equivalent proportion of cocoanut oil. The soap is filled with sal soda, just as in the case of ordinary settled soap, and then framed.

IV. In some factories the nigre is "bleached," and the kettle then charged with fresh stock on top of it, using each nigre in this manner without making dark soap. The bleaching may be carried out as follows: The nigre is grained on salt and the waste lye run off. Water is then run in to close the soap, and enough lye to give a little sharpness. Tin crystals (stannous chloride, muriate of tin) are then added, previously dissolved in a little water, about 1½ to 2℔ of this bleaching agent being used for every 300℔ of nigre, according to how much rosin it contains. Open steam is turned on and the mass boiled for 2 or 2½ hours. When the soap is again grained on salt and the waste lye run off, the nigre will be found as light colored as the soap was from which it was obtained. It is then used as stated above, by being boiled together with fresh stock.

As the nigre deteriorates more and more, with each succeeding batch, irrespective of its color, it may be well to use it up from time to time anyway, to get rid of it.

V. Other uses have been occasionally recommended, such as making "soap stock," for laundries, soap powder, floating soap (taking advantage of the frothy nature of the soap resulting from graining nigre), etc., etc. Considering, however, the inferior nature of the nigre, the values of the different suggestions may be readily estimated by the soap maker. It is useless to describe the proceeding in such cases, since they are rarely employed, and are not difficult to imagine.

SCRAPS OF SOAP.

The "scraps" or trimmings of soap resulting from cutting up a frame into slabs and bars are best utilized by remelting them in a special apparatus, as hereafter described. (Chapter XIV.) But where such an apparatus is not used in the factory, other expedients must be employed. One way to use them, if they had been

Using scraps without remelting.

filled with sal soda, is to add them in the kettle at the end of the rosin change, in a succeeding boil, so that the carbonate of soda may be utilized by combining it with the rosin. (If added in the kettle when saponifying neutral fats, the filling would go into the waste lye and be lost.)

A more satisfactory method, which also saves the kettle space, consists in adding the scraps, cut into small pieces, to the soap in the crutcher, the latter being used somewhat warmer than usual in order to make up for the low temperature of the scraps, and the filling used somewheat weaker, to make up for the dry condition of the chips. This has at least one advantage, namely—that the heat used for remelting is saved, but it makes the correct framing of the new soap somewhat more difficult. (See, also, the chapter on "Remelting" and under "Cold Soap.")

WHITE SETTLED SOAP.

Stock for white settled soap.

To make a white settled soap the properties of the rosin used in the yellow soap just described are generally supplied in some other way, namely, by a proper selection of fats, as a settled soap from tallow or similar fats alone dries out strongly, and thereby becomes very hard and too difficultly soluble for practical use. Advantage is in this case most frequently taken of the property of cocoanut oil soap to retain moisture, thereby not only preventing undue drying, but also—to a great extent at least—the general discoloration to which a pure tallow soap is subject on aging. The addition of cocoanut oil also aids the settling out of impurities, as may be seen from the fact that the nigre from a pure tallow soap is much lighter in color than that from a soap in which some cocoanut oil was used with the tallow.

Tallow and 10 per cent. of cocoanut oil furnish a good, hard, and white soap, suitable for all household purposes, and the following description of making a white settled soap is based on this composition.

Other fats may of course also be used, instead of the tallow, such as lard, and bleached palm oil, for instance. Grease generally furnishes off-colored products, and cotton seed oil causes yellow spots on drying, especially if the soap is not filled.

FIRST CHANGE.

The tallow and cocoanut oil are clarified together in the same manner as stated under "Rosin Soap," and are then saponified,

beginning with lye at say 12° B., of which about one pound is run into the kettle for every three pounds of stock, while boiling on open steam.

When the quantity of lye stated has been well boiled with the fats, the contents of the kettle form a homogeneous mixture, whereupon saponification is continued by running in strong lye at 25 to 30° B. which is run in slowly, under gentle boiling, so that the boiling is not interrupted, nor the soap allowed to open. If the latter irregularity should take place, it is a sign that the lye has been added too fast, and a little more water may then have to be added until the mass closes again.

When the soap becomes transparent and tastes sharp, the saponification change is finished. In order to make sure on this point, a few minutes' rest is allowed, and if the sharp taste remains on then boiling again, enough lye has been added. Otherwise a little more lye must be run in and again boiled through.

During this change the lye must never be allowed to run in so slowly that the strength is at any time entirely absorbed, nor so fast that the soap opens.

If the lye is used too strong or in great excess, the soap opens and saponification is retarded by it; on the other hand, if the soap is weak it will suddenly become thick and difficult to manage. In the latter case strong lye must be run in at once, and the soap be thoroughly crutched, while the steam is only turned on far enough to barely keep up boiling.

When the paste is transparent and retains a slight sharpness after the lye has been turned off for some minutes, it is grained with salt or brine, and the waste lye allowed to settle, as described in the previous boil.

When cocoanut oil is saponified it naturally has a somewhat sharp taste which is sometimes mistaken—by those not used to working with it—for alkaline strength.

The first change may also be carried out by first saponifying the tallow alone, and graining it on salt as in the rosin soap described; then running off the waste lye and adding the cocoanut oil, and boiling with more lye in much the same manner as the rosin was saponified in the same boil just referred to. The weaker lye employed in this case for the tallow is supposed by some to bring about a larger yield of soap, as it is more favorable to thorough saponification.

STRENGTHENING CHANGE.

After drawing the waste lye from the first change, new lye at from 20–24° B. is run into the kettle and the soap boiled for an hour or longer, until all parts of the fat are thoroughly saponified.

The strength and quantity of the lye required for the strengthening change depends on circumstances. If the soap was not grained strongly at the end of the first change, it will hold considerable water, and a stronger lye is then used than would be proper if the soap contained but little water. Again, if open steam only is used, the lye may be stronger than when a closed coil is used for boiling, on account of the water introduced by the condensing steam. As to the quantity, about 30 gallons of lye to 1,000 lbs. of fat used will be required for an average sized kettle.

At the end of this change the soap should be in a soft, large curd, so as to drop the lye well; if grained too far, it will require too much water in thinning and cause an excessive nigre.

The lye from the strengthening change is carefully removed after a sufficient rest, so as to free the soap from it as perfectly as possible, and is saved to be used for its strength for some dark soap.

FINISHING.

Water is run into the soap to thin it, open steam being turned on for gently boiling the mass. The quantity of water again depends on the condition of the soap, and may be 8 to 10 gallons for every 1,000 lbs. of stock to begin with. The soap becomes close, and a sample must be smooth on the top. If it rises high in the kettle and the sample separates no lye it is sufficiently thinned out; otherwise more water must be added and well boiled through. The soap is then allowed to settle until cooled off to about 160° F. and the good soap framed.

FRAMING.

The soap is generally framed pure, as it is sufficiently hard without filling (and in that case, if made from good stock, would answer well for "milling" into toilet soaps). The larger the frames used, the slower will the soap cool, whereby the texture will improve and the soap be harder on cutting than if cooled rapidly in small frames. But *if wanted*, this soap may be filled—like a rosin soap—in the crutcher, with about 8 per cent. soda solution (36° B.), to which may be added from 6 to 8 lbs. of borax, or other filling desired, to each frame of 1,100 lbs.

GENERAL REMARKS.

As the manufacture of this soap resembles in most particulars that of the rosin soap already described, it was unnecessary to repeat here all the details regarding the various operations; for further particulars the reader is therefore referred back to the description of making "Rosin Soap" (page 149, etc).

It may be remarked in this connection that the *true white Castile* soap (so-called from the former kingdom of Spain, where this soap was originally made in very large quantities), is made by "settling" a pure olive oil soap. In this country it is imitated by making a similar article, in which the olive oil is substituted by such fats (in various proportions) as tallow, cotton seed oil, cotton stearin, bleached palm oil, etc. The true Castile soap, as may be readily imagined, becomes extremely hard with age, and forms a slimy mixture with cold water rather than a lather. It is used mostly for pharmaceutical and technical purposes (by silk dyers, etc.); and according to the use for which the American products are intended, its properties are more or less sought to be imitated. There are also numerous soaps brought on the market which simply trade on the good name of the original, and are made after almost all processes of soap making known to the trade, having generally no similarity whatever to the true Castile soap. **Castile soap**

An imitation of Castile soap for manufacturing purposes is often made in this country from equal parts of tallow and cotton seed oil, settled coarsely and crutched till nearly cold, without filling. It is sold in barrels, or framed and cut like other soaps.

Settled soap without cocoanut oil or rosin.

A settled soap from tallow alone, or from cotton seed oil alone, or from a mixture of the two, may be made in the same manner as other settled soaps, but it should be thinned down only so far as to be still in a half-grained state. If it were thinned out as much as is usual in a rosin soap it would form an excessively large nigre, owing to the great quantity of water required for thinning such a soap to that degree. The good soap would also hold considerable water and shrink very much on drying. Such soaps may also be filled like a settled rosin soap, but will not take quite as much filling. If made of cotton seed oil only the soap will be rather too soft for cutting it into bars.

A modified process.

A somewhat similar soap as the one here described is frequently made in Germany by a process not well known here, and which may be briefly described, as follows:

The tallow is saponified alone, grained on salt and boiled well

on fresh lye of 15° B. (over open fire in most cases) till the soap is well grained; 25% of cocoanut oil is then added and boiled until the sharpness of the strengthening lye is absorbed, about 1½ lbs. lye at the strength named being used for each pound of cocoanut oil. The thickly fluid soap formed by this operation is then thinned with salt water until a sample is slightly wet on cooling. The kettle is then covered, the soap allowed to settle and framed at about 190° F. (The formation of nigre in this case is caused by the decreased capacity of the water to hold the soap in solution, when salt water is added; this action depends on the property of cocoanut oil soap of dissolving in moderately strong salt water, and not enough salt water is added to entirely separate the soap).

CHAPTER VIII.

Boiled Down Soaps.

It has already been stated (page 143) that the "boiling down" of soap is a process by which, in the first place, a product is made which contains less water in its composition than is commonly met with in ordinary soaps. As a consequence the effect of this operation of "boiling down" is to render the soap harder, less rapidly soluble, and—unless the boiling down is carried very far—to produce the natural "mottle" or "marble," which in former times served as a guarantee that the soap contained no excessive amount of water. The marbled appearance of soap that has been boiled down is caused, according to the generally accepted theory, by a process of crystallization through which the coloring matters in the soap are expelled from the white, crystalline parts (stearin soap), and become enclosed in the more slowly solidifying, non-crystalline portions (olein soap), coloring the latter by their presence. On closely examining such a soap under a microscope, it seems that the small particles of stearine soap become so closely packed together that they force the particles of coloring matter into the softer, more spongy olein soap. (It may be doubted if the term "crystallization" can be rightfully used for this phenomenon, considering that the mottle forms at so high a temperature, at which a real formation of crystals can hardly take place). In the old process of making the true Castile soap, if too much water is present, the thin consistency of the soap causes the coloring matters to settle to the bottom of the frame, and from this circumstance arose the (formerly quite correct) belief that a marbled soap was one necessarily containing but little water. This was undoubtedly true in the olden times, but at present there are ways of making marbled soaps that contain more water than was ever dreamed of in those times, even in regard to their white soaps.

The mottle

Of the boiled down soaps there is really but one variety that

is made in this country to-day to any considerable extent—one that is generally known as "German Mottled." The genuine Marbled Castile is also made by boiling down a soap (made by saponifying olive oil), but the soaps made in imitation of it in this country are mostly made in almost every way but by boiling down.

GERMAN MOTTLED SOAP.

This really excellent soap, as originally made in Germany by the oldest process known, was composed of tallow and lye made from wood ashes; now it is made there in various qualities from a variety of fats and oils, and artificial soda. The fat used principally for German mottled soap in the United States is oleic acid (red oil), which is eminently suitable for this article.

Stock for German mottled soap.

Briefly stated, "German Mottled" is a soap which has (generally) been settled, and is then boiled on "pickle" to deprive it of water. The fat is therefore selected, and the manufacture in the first stages carried out in a manner similar as in the case of the settled soaps described in the foregoing pages, with this exception, that the composition of fats used in "German Mottled" should be somewhat softer on an average than is used for simple settled soap, as otherwise the finished product is very apt to become exceedingly hard and brittle on drying, and to crack. These soaps are therefore best made of red oil, or cotton seed oil, or of tallow and soft grease, or any similar combination of stock, and, generally, without the use of rosin.

On account of the softness and great solubility of red oil soap a smaller proportion of rosin used in connection with it, if any, is here preferable to that used in a settled tallow-rosin soap. Besides, a red oil soap darkens considerably on aging, and much, or very dark rosin, is for this reason also undesirable. With cotton seed oil, however, from 25 to 30 per cent of rosin gives a good product.

Having already described in the previous chapter the saponification of tallow, we shall base the following description of making "German Mottled" soap principally on the use of red oil, as this gives us an opportunity of noting the difference between working tallow and working with red oil.

FIRST CHANGE.

Method of saponifying red oil.

The lye required for saponifying the red oil is run into the kettle and brought to a boil.

This lye may be caustic lye, or (red oil being a free fatty acid), it may be prepared by dissolving carbonate of soda (soda ash) in water by the aid of steam, until it marks 20°B. when hot. This is allowed to settle for a day or two, and the clear solution run off into the kettle. Supposing a pure grade of soda ash to have been used, about equal weights of lye and red oil will then be required for saponification. Of an impure alkali more would, of course, have to be used, as the inert salt does not take part in the saponification. [In case carbonate of soda is used, carbonic acid is evolved during boiling, which is dangerous to inhale in considerable quantities. As it is heavier than air, some provision must be made to carry it off therefore; on account of its weight it will not rise like steam, but, although invisible, remains near the floor, so that it is best got rid of by opening the doors of the kettle room to let it escape into the atmosphere.]

Precautions when soda ash is used.

In the boiling lye 25 to 30 lbs. of salt (according to purity of lye) may be dissolved for every 1,000 lbs. of red oil, as an additional safeguard against "bunching." The lye being at a brisk boil, the red oil is run in and good boiling kept up. If boiling is allowed to become slow, lumps are liable to form which are difficult to dissolve again; and as the fatty acid combines very readily with the alkali, the operation of saponifying proceeds most rapidly and easily if the red oil is run into the kettle already somewhat heated. For the same reason it is advisable to run the oil into the kettle over a piece of sheet iron, so arranged that it breaks up the mass in a spray-like manner, instead of running it in in a thick, solid stream.

Means of preventing bunching.

After all the fatty acid has been run into the lye, boiling is continued for an hour or more, until all is thoroughly saponified, and the soap has become separated from the waste lye.

If cotton seed oil, soft grease, etc., are used instead of red oil, the first change is of course conducted in the ordinary manner, as has been described under "Settled Soap." The reversal of the process (i. e., running the fatty matter into the lye, instead of *vice versa,* when red oil is used) is generally adopted because the ordinary mode of conducting the saponification of neutral fats would result in an aggravated case of "bunching" when fatty acids are saponified.

* * * * * * *

[The waste lye may be run away after sufficient rest to settle the same, and in case any rosin is to be used in the soap, it may

then be added for saponification, just as in making an ordinary settled rosin soap. As said before, "German Mottled" is ordinarily made without rosin, but there are some manufacturers, especially those who use other stock than red oil, whose German Mottled soap contains about 25% of rosin to each 100 lbs. of fat. The saponification of rosin having already been described, we will here give another mode of working which may be adopted—to suit the opinion of the soap-maker—according to the purity and color of the stock used. This method is as follows:

Run into the kettle (without having run off the waste lye) about 520 lbs. of caustic lye at say 35° B. for every 1,000 lbs. of rosin to be used. Then add the broken rosin.

The exact strength of lye most practicable to be used in this case cannot be given, as this depends on whether open or closed steam, or both, are used for boiling and on the quality of the rosin, and particularly on the amount of waste lye in the kettle. If only closed steam is used the quantity of lye named may have to be diluted with water. The lye is here used very strong on account of the large quantity of water contained in the kettle when the waste lye has not been previously run off.

When all the rosin has been added the soap should no longer be open, but rather in the condition of a soap thinned out in "settling," as it will then be more readily saponified. After boiling well when the rosin has been added, the soap is grained with salt and the waste lye drawn off after sufficient rest.

The soap now is practically in the same condition as it was in the boil of settled soap after the rosin change, only it is softer on account of the softer stock used. It may now be repeatedly drawn together with water, or better with weak lye, and grained with salt to wash out the impurities as much as desired.]

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When the stock is thoroughly saponified the soap is grained with salt, and one or two additional changes are given to improve the color and consistency, after which it is boiled down, as described below, or instead it may be first settled.

SETTLING.

Settling not absolutely necessary.

The thoroughly formed soap may now be "boiled down" at once, but for a first-class article, for improving the color, or when dark stock has been used, the soap is first thinned with water and allowed to drop the nigre, whereby it is clarified, and the free alkali

removed, which is quite as important in this as in "settled" soap. This process has been described before, and need not, therefore, be repeated here; it may be remarked, however, that the finer the soap is settled the larger will not only be the nigre, but also the proportion of water in the clear soap, and the longer time will then of course be required for the boiling down. A short settle only is, therefore, usually made for German mottled soap.

BOILING DOWN.

The clear soap, if it had been settled, is pumped off from the nigre through a strainer into a clean kettle, into which the "pickle" has previously been run (or if the soap was not settled the pickle is simply run into the kettle), and closed steam is turned on. In regard to the proper composition and strength of this pickle much diversity of opinion exists.

As to the Composition: The pickle may consist simply of salt dissolved in water. Boiled down on this the soap will lose part of the water it holds, will mottle very nicely, and will form a satisfactory product; only it will have, on solidifying, a dry, brittle texture, which is not at all desirable. To obviate this drawback carbonate of soda (soda ash) is frequently added to the salt water to form the pickle. The texture of a soap boiled down on a pickle consisting of half salt and half soda ash solution is perceptibly better than if boiled on a salt solution alone, but here the trouble is that the traces of carbonate remaining in the soap will cause the latter to effloresce on drying. According to the composition of the pickle the texture may, therefore, be improved, at the expense of appearance.

As to Strength. When boiling the soap on pickle the latter tends to become more concentrated by the evaporation of water, but at the same time it withdraws water again from the soap. In this manner it is possible to boil on pickle until the soap has lost considerable water, and yet the pickle itself will be of the same strength as at the commencement of the operation. It is obvious, however, that the proper strength at which the pickle is first introduced depends greatly on various circumstances. A soap may have been more or less finely settled and consequently contains more or less water to be evaporated.

The same is true in regard to the kind of stock (and proportion of rosin, if any, used). Again, the arrangement of the steam coil and shape of kettle may be such as to require a greater or

smaller quantity of pickle; if a large quantity is used it should not be so weak, in order not to introduce too much water with it. A finely settled soap therefore requires stronger pickle for boiling down in a reasonable length of time than a soap which contains but very little water to be evaporated. Besides, soap makers who have had long experience in making this soap do not agree in this respect in their opinions, even under the same conditions regarding stock, etc. The proper strength of pickle for this purpose is variously named at from 8° to 20° B. (and by some even up to dry salt). The stronger the pickle the more rapidly will the operation be finished.

The soap and the pickle made by dissolving salt alone, or salt and soda ash, in water, to a strength of from say 14° to 18° B., are boiled together on closed steam, and the progress of the operation is closely watched. The appearance of the soap and the strength of the pickle is carefully observed from time to time, as the boiling proceeds, and after making a few boils of a given composition as to fat and rosin the soap boiler will have gained the necessary experience and correct judgment in the matter, which can only be acquired by practice and intelligent study.

The mottle—formed by impurities of the raw materials inclosed in the non-crystalline portions of the soap—can only form when the hot soap has a certain degree of fluidity. It will develop strongly if the soap contains much water; in other words, if the mottle is too pronounced the soap has not been boiled down far enough. If boiled too far, on the other hand, the mottle cannot form at all, as the lack of water then renders the soap too thick to allow of proper crystallization in the hot soap by means of which the mottle is to be formed. The salt used in boiling down supplies the necessary mobility of the mass to permit crystallization.

Saving boiling down.

A method, not exactly to be recommended, but sometimes adopted in order to save boiling down so far, is to boil down as much as desired and sifting some finely ground, pure soda ash into the soap (in the crutcher). The soda ash absorbs the surplus of moisture and acts as filling. No special proportion of soda ash is necessary to be observed, as it is not likely to effloresce (as it would certainly do in the case of settled soap, unless used just in the right proportion).

FRAMING.

When boiling has proceeded to a point judged to give the proper mottle, a rest of several hours is allowed to separate the

pickle, and the soap is then ready for framing, which is carried out in the same manner as in the case of settled soap. In small iron frames the soap cools quickly and shows but little mottle; if a more pronounced mottle is desired, large wooden frames are used.

Filling might also be added, if desired, but generally boiled down soap is framed pure, as there is no real benefit regarding the quality of soap in boiling down if filling is to be added. If the stock used in this soap was not thoroughly saponified it will have a tendency to retain an admixture of some of the pickle, and thereby cause trouble in the frame.

Pressing.

On account of the "short" texture of the soap it is not pressed in the ordinary manner, but merely cut in bars and stamped on the sides with a simple stamp. Potash lye used for part of the soda lye, especially if soda ash was used in the pickle, has the property of improving their texture so much that the soap so made can be pressed in the ordinary manner.

General Remarks.

In order to avoid unnecessary repetition only the considerations peculiar to boiled down soaps have been mentioned in detail in this chapter; for further particulars refer to the chapter on settled soaps.

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In this place it may be proper to briefly state how the genuine Marbled Castile soap, also known as "Marseilles" soap, is made in European countries.

Genuine Castile soap.

Olive oil (from the second pressure of the fruit), with or without the addition of other oils, is saponified with lye at from 10 to 20° B. Coloring matter is then added, such as copperas (sulphate of iron), which, together with the sulphur compounds either present in the crude soda or otherwise added afterwards, causes a greenish black color by the formation of ferrous sulphide. The marble formed by these materials changes to yellow on exposure to the atmosphere. The soap is grained on strong lye, which contains considerable salt in solution, and the waste lye is then run off. It is then once more boiled on strong "salted" lye and the waste lye drawn off again. Fresh lye of 22 to 25° B. is then added and the soap boiled until saturated with alkali and strongly boiled down. A little water is then carefully added to bring the soap to the right condition for marbling, or successive portions of

lye, gradually decreasing in strength, are used for the same purpose. The soap is then run into large wooden frames and left to crystallize, in order to form the marble. (The coloring matters collect in the non-crystalline portions.)

For white castile soap the process is the same, but omitting the coloring and thinning the soap for "settling," first with lye at 6 to 7° and then with still weaker lye, and at last with water.

Of course there are variations from this process, as well as in making all other soaps. The appliances and lye used in the foreign countries are very different from those used in the United States. The lye is still made to some extent from kelp, or more frequently by causticizing soda ash. Differently prepared lyes are used for different operations, and the boiling of a batch of soap over the open fire still used there, and the many changes of lye, generally take from three to four days.

It will be noticed that the mottle is produced from the same cause in true Castile soap as in "German Mottled," only the conditions required for mottling are brought about in different ways, for while in the former the soap is boiled to a grain and then thinned with lye or water, the German Mottled is made by boiling on pickle a soap already containing too much water. In order to make the mottle more intense, coloring matter may be added to the soap.

Soaps that have been boiled down immedialy after saponification, without settling, invariably contain some free alkali. For this reason sulphate of iron, which was formerly employed as coloring matter in such soap, was added in such a manner as to combine with the free soda, thereby setting the iron free to form the marble and also neutralizing the free soda present. The oxide of iron and other similar pigments now generally used do not possess this neutralizing action.

WHITE BOILED DOWN SOAP.

If a hard white soap is to be made from soft materials, such as cotton seed oil as the only stock, it requires boiling down in order to overcome the natural softness of a pure cotton seed oil soap. Such soaps are made but little at the present time, owing to the relative prices of fats, oils and rosin. Their manufacture may be briefly described as follows :

(As was said in the description of cotton seed oil, this stock, when used in boiled-down soaps, has not that tendency of causing yellow spots, as in settled soaps.)

FIRST CHANGE.

The oil is run into the kettle, along with twenty gallons of water for each 1,000 lbs. of stock. Open steam is turned on and lye at 15° B. run in. When saponification is approaching its completion, the strength of lye is increased to 20° B. The lye should be made of high-grade caustic and plenty of time allowed for saponification, as cotton seed oil combines less readily with alkalies than other oils and fats. When the soap is well formed and has a sharp taste, it is grained with salt in the usual manner, so that the clear lye separates from a sample on the paddle.

STRENGTHENING.

The spent lye is run off and open steam turned on. Water is run in during good boiling till the soap is smooth and bright and has the appearance of a soap ready for settling. Fresh lye is then run in and boiling continued until the soap begins to open again.

The strength of this lye depends somewhat on the amount of water previously added for thinning, on the steam—whether closed steam is used together with the open steam or not—and also on the judgment of the soap boiler. A strong lye would finish the operation more rapidly, but weaker lye would permit of longer boiling before the soap becomes grained, and long boiling, as already stated, is required for thorough saponification, especially for cotton seed oil.

When the soap begins to open, salt is added to assist in graining, so far that the clear lye separates.

BOILING DOWN.

The lye is run off again and saved for its strength. Pickle (made in the manner explained under "German Mottled" soap) is then gradually run in under constant boiling. When the soap has been boiled down like the German Mottled described, steam is turned off and the pickle allowed to settle.

FRAMING.

Frame in the manner as in the case of the "German Mottled" soap.

CHAPTER IX.

Eschweger Soap.

While in this country the "settled" soaps are by far the most prominent, and the "boiled-down" soaps constitute nearly all the remainder of those made by boiling, yet there are processes of soap-boiling in which neither of these operations are employed. Of this class, for instance, are the "run" soaps already referred to, which were made largely, especially in former years. Another variety also coming under this head is a soap sometimes made here in imitation of Castile soap and known in Germany as "Eschweger," which was first made in 1846 by a firm of German soap-makers (Dircks & Thorey). The quantities of these and similar soaps made in this country at the present time are not so large as to require on that account an extended description of their manufacture in these pages; but, inasmuch as it affords an opportunity to show the manner of working under different conditions, they may be included to some advantage.

In making most of the better grades of these soaps advantage is taken of the property of a mixture of tallow and cocoanut oil to saponify readily with strong lye, thereby furnishing a soap containing a comparatively small amount of water, without the necessity of separating the waste lye. At the same time the foreign salts introduced with the lye—which are run away with the waste lye in the ordinary manner of boiling, but remain in the soap in the present case—do not exert their usual disturbing influence when cocoanut oil is largely used together with the tallow or other similar fats. (In fact, a pure cocoanut oil soap requires an excessive quantity of salt in order to separate it from the waste lye, but will appear hard on drying even if an amount of salt solutions is present which would entirely separate a soap made of ordinary fats alone).

In consequence of this latter property, some very highly adulterated soaps are made by saponifying fats composed largely or wholly of cocoanut oil and adding to the soap considerable quantities of various salts dissolved in water.

Stock for Eschweger. "Eschweger" is a marbled soap, made by saponifying tallow and soft fats, together with about one-third of their weight, or more, of cocoanut oil. Owing to the properties of the latter oil, such soap, in absorbing considerable salt solutions, thereby becomes of a peculiar consistency, while hot, which causes crystallization, and thereby the formation of "marble" or "mottle," on cooling in the frame; at the same time, it holds much more water than one that has been mottled by boiling down a soap made entirely of soft fats.

The fat used may be equal parts of tallow and grease, besides cocoanut oil, to one-third of their combined weight, or the grease may be substituted by cotton stearin, or cotton seed oil, or any similar combination may be used.

Indirect method. The tallow and grease may be saponified alone at first, grained, the waste lye run away, and the soap so obtained then boiled together with the cocoanut oil and the lye required for the latter and the required salts; but generally the following plan is adopted:

Direct method. The fats are clarified together by boiling on open steam, and the water formed and the impurities drawn off after settling. They are then saponified by slow boiling with lye of an average strength of say 25° B., and the quantity of lye is gauged so as to have the soap very nearly neutral at the end of the operation, as there is no separation whatever of waste lye. All that goes into the kettle also goes into the soap (excepting, of course, a certain amount of water removed by evaporation).

The lye should be used as strong as circumstances will permit, since any surplus water can only be removed through evaporation by boiling, which is very difficult unless open fire is used for making these soaps. For this reason the tallow is in some factories saponified alone at first, with weak lye, to insure perfect saponification, the waste lye then drawn off, and the cocoanut oil added and saponified with stronger lye.

Salts required for mottling. This soap, when well formed in the kettle, must contain considerable carbonate (or silicate) of soda and common salt, so that it may become sufficiently "short" to permit the formation of a mottle. These salts are added either when saponification is nearly complete, as described below, or the presence of the carbonate

may be insured by using low-grade caustic for making the lye, and the salt be added afterwards. During saponification sufficient lye ahead should always be in the kettle (until near the end of the operation) to insure against undue thickening of the soap, which is especially liable to occur if tallow only is used together with the cocoanut oil. When weaker stock, such as cotton seed oil is used, there is less danger of this occurring.

Towards the end of the saponification the physical character of the soap must be carefully watched, and the necessary appearance brought about by various additions, according to circumstances, as follows:

Signs of properly finished soap.

If the soap formed is thin, and a sample set on glass has a gray ring around it, has a dull appearance and sharp taste, it indicates an excess of lye, and in this case enough cocoanut oil must be added to take out this surplus strength.

If the sample is thick, glassy, and tough while hot, and soft on cooling, and appears heavy, the steam escaping by forcibly "puffing" through the mass, more lye is required. If it is soft on cooling and yet sharp, more water must be added, as the lye has then been too strong to combine properly.

If the soap boils up high and thick, and a sample is tenaceous on the trowel, water must be evaporated to shorten it.

If it is very clear and tough, and a cold sample is very stiff and rubber-like, salt or brine must be added, according as more water may be needed.

If the soap contains too much salt, more cocoanut oil and lye will have to be added. Too much salt makes the soap rough and brittle, and if the excess is very great, may even cause it to settle.

A properly finished soap of this kind is clear and has a bright surface; the steam of the evaporating water escapes from numerous places all over the surface (called "roses" in Germany, owing to the similarity of the formations to this flower) and a sample on the paddle must have enough consistency while still hot not to spread out very much; when sliding off the inclined paddle it must break off short, and the paddle can be seen in places between the clots of soap; a slight sharpness should also be apparent.

Proper quality of lye for Eschweger.

The lye used in saponifying the fats may be of high-grade caustic at first, and the required salt and carbonate of soda added after the materials are thoroughly combined, or the salts may be added from the start. A close study of the lye used is necessary in making this soap, and careful observation and considerable

practice are required before it can be made with uniform success. The presence of various salts is of far-reaching effect, and, unless the nature of the lye used at the outset is well understood, it will be next to impossible to form a correct idea of what salts must be added.

If too little lye or salt is used, the soap will be soft and tough, instead of short, thus making it spotted throughout, instead of mottled, if framed in that condition. If too little water is used (or the soap evaporated too much) it will also be spotted; with too much water the mottle will form badly, or the soap will even separate a nigre. The presence of too much salt causes the soap to feel wet and cold while fresh, the mottle has a bad appearance, and on drying the soap effloresces strongly, and becomes rough and brittle.

If a very caustic lye has been used at first, the apparent sharpness sometimes disappears when the salts are added, thus indicating that the fats were not fully saponified. In such case, more lye must then be added.

If very caustic lye has been used, solutions of carbonate of soda (sometimes silicate of soda) are added during the boiling, or the lye is made at once by dissolving 20% of soda ash with the high-grade caustic. As the various foreign salts are unable to form a chemical combination with fat, they merely contribute to give the soap the required mobility to permit crystallization (and consequent mottling) in the frame; they also prevent the finished soap from drying out too rapidly, and, of course, also increase the yield of soap.

As was observed under "boiled-down" soaps, a pure tallow or olive oil soap must be brought into proper condition (i. e., its toughness reduced) by traces of salt introduced in the boiling-down operation in order to enable the stearate of soda to crystallize and form a mottle; at the same time, such soap holds but very small quantities of salt. Pure cocoanut oil soap, however, is quite different, for it forms a tough solution even in the presence of quite considerable amounts of salt and water, of which a large quantity is required to cause the right consistency for mottling—so much, in fact, that a mottled soap made from cocoanut oil alone could scarcely be referred to as "pure" soap in the true sense of the word. Thirty to thirty-five pounds of cocoanut oil to 100 of tallow, or similar fats, furnishes a good product which is much liked in some localities, and forms a beautiful mottle.

A soap having very little sharpness, only little water, and a correct proportion of foreign salts, inclines to a large mottle. A smaller mottle results if the soap is somewhat sharper and contains somewhat more water, provided again that sufficient foreign salts are also present.

Large and small mottle.

No hard and fast rule can be given, what kind and how much salts to add; a trial will determine this, according to the composition of the fats and lye and the nature of the soap intended to be made. Ordinarily, lye made from low-grade caustic is used to supply the necessary carbonate, and the final corrections made with salt dissolved in water.

Many, however, prefer to use high-grade lye for saponification, adding from 15 to 20% silicate of soda, either at once or after the materials have joined; then the soap is shortened by adding say 3% of soda crystals, and the final correction is made with a solution of common salt, until the required appearance in the kettle indicates that the soap is well made.

Effect of various salts.

Carbonate of soda—either present in the lye, if made of low grade caustic, or added afterwards—causes a beautiful mottle and a high yield of soap. But if used as the only salt, the soap will incline to effloresce or "whitewash," especially in winter.

Carbonate of potash, substituted for part of the soda, avoids, or at least decreases the latter difficulty, but the marble formed will be less beautiful.

Common salt causes a very fine mottle, but the soap will bind less water and the yield will be correspondingly less from a given amount of fat.

Silicate of soda thins the soaps, and if used, less of the other salts must be employed, so that there is really no gain in using it for this soap, except in that, while the yield is not as large at first the soap also does not dry out as much afterward. When it is employed for this soap the lye should be more caustic than when sal soda is added instead, and the soap should have a slight sharpness to guard against the silicate crystallizing out. As high as 30 per cent. may be worked into the soap, but 15 to 20 per cent. gives a better product and is safer against irregularities in boiling. (Soaps of similar composition as to fats—not mottled—are sometimes filled by boiling in this manner with as much silicate—diluted previously by boiling with water—as the weight of the fats used.)

The less cocoanut oil enters into the soap, the less water and

salts must of course be added, and the smaller will be the gain in soap.

Coloring matter.

When the soap in the kettle shows by the appearance described that it is in the right condition, the desired color (copperas, ultramarine blue, Indian red, etc.) stirred into boiling hot water to which a little salt has been added, is put into the soap, and well boiled through with open steam until the color is uniformly distributed.

The salt is added to the color in order to prevent it from clotting together; strong lye might be used instead if the condition of the soap is such as to make it preferable. It is well to take a sample of the soap out of the kettle and see if the color mixes with it evenly; if not, more salt must be added. The soap and coloring mixture should both be as hot as possible, in order to be readily mixed.

The amount of coloring matter to be used, it must be understood, has no effect on the *quantity* or formation of the mottle; it only affects the intensity of its color and must be gauged accordingly. 8 to 10 lbs. of Venitian red to an ordinary frame will produce a good effect. Other colors, which may be used in proportions according to their nature, are Indian red, ultramarine blue, ivory black, etc.

Framing.

This finishes the boil, and the soap is run into the frames, where it is crutched for a short time and covered up to keep it warm. In the course of three hours, if the marble is seen forming, the frames are uncovered and the soap allowed to cool. Wooden frames are best employed in this case, in order to avoid chilling the soap on the sides.

Boiling by steam.

This soap is made mostly (in Germany) over an open fire, but this affects its color disadvantageously, and the soap may be boiled as readily with closed steam at a pressure of 3 to 4 atmospheres by managing the lye so that no excess of water is present that requires evaporating.

In making this soap a record should be kept of the grade of caustic used and the quantity and kinds of salts added; these notes will then serve as a guide for the next batch until more practice has been obtained. If the soap mottles properly, but effloresces on drying, the lye for the next boil should be used more caustic, and more potash and salt used instead of carbonate of soda.

ESCHWEGER III.

A soap made as described, of about one-third cocoanut oil and two-thirds of other fats, with a yield of 200 to 215 lbs. of soap from 100 lbs. of stock, is considered as Eschweg soap proper. If, however, the fat used consists nearly all or entirely of cocoanut oil, and the soap is shortened with various salt solutions until it is in proper condition to form a mottle, the yield will be increased to 300 to 350 per cent. Such soaps are hardly ever made in this country, but are quite well known in most other countries where they are variously sold as "blue mottled," "Eschweg III." etc. They are generally considered still more difficult to manufacture with uniform success than Eschweg soap proper, and in most cases are the dread of those to whose lot it falls to make them. We will briefly describe the process:

Definition of Eschweger III.

These soaps are made most frequently by half-boiling, the fat being saponified at a temperature of about 190° F. and the soap formed in the course of several hours' rest in the kettle is then filled with the necessary salt solutions. However, boiling the fat and lye before filling until thoroughly saponified would prevent many failures in the process, as they are most commonly only the result of free fats being present, and soap so made would dry out less than when the stock had not been perfectly saponified. For the proper formation of the mottle in these soaps every soap-maker adheres very closely to certain proportions of materials which he has found by experience to give the desired result, and at the close of a boil carefully watches small samples taken from the kettle, to see if any corrections are required.

Boiling vs. half-boiling.

The following formula will serve as an example:

100 lbs. cocoanut oil.
130 lbs. caustic soda lye 24° B.
20 lbs. sal soda.
42 lbs. salt water 23° B.
20 lbs. potash solution 30° B.

The cocoanut oil is saponified with the lye at a temperature of 190° F. and when the materials have joined, some of the salt water is added, enough to prevent thickening.

Or the fat may be saponified by boiling, in which case the water lost by evaporation must be restored, and the salt solutions are then rapidly crutched in when the soap has cooled down somewhat.

Next the potash solution, then the sal soda, and lastly the

remaining salt water is crutched in and the temperature maintained for some time at about 200° F., covering the kettle and occasionally crutching through. 1½ ounces of ultramarine blue are then dissolved in 4 lbs of water to which 4 lbs. of silicate of soda and 1 lb. 25° B. caustic soda lye are then added. A small portion of the coloring mixture is added to the soap, and samples taken. (Or a 20 lb. sample of the soap is taken and some color added for the test, before coloring the soap in the kettle.) If the silicate is observed to crystallize or form flakes, a little more lye must be very carefully added to the coloring solution until it will mix easily and uniformly with the soap. The kettle, after coloring, is covered for an hour, when samples are taken out. If the soap is then uniformly colored blue, it has too much strength, and some cocoanut oil must be added, and time allowed before another sample is taken out. If the mottle has, on the other hand, been formed rapidly, the soap is weak and requires a little more lye. When samples appear satisfactory (they should be preserved for comparison with later batches) the soap is framed at 165 to 170° F. and the frames kept covered for the first hour or so.

A good way to judge whether the soap is right for mottling, is to take out three or four samples of 10 lbs. each, and add different small proportions of cocoanut oil to the samples, and cover up for half an hour. According to the mottle formed in this time in the different samples it may be seen whether oil should still be added into the kettle, and how much.

If the mottle forms in the frames, but drops to the bottom, it may be brought up by crutching, provided the soap has not yet cooled below about 140° F., as it will form again. A weak soap mottles most readily, but inclines most to dropping the mottle in the frames; it is therefore best, when judging of the samples, not to go entirely by the most beautifully mottled sample. A somewhat strong soap forms a smaller mottle which is not liable to drop, but sometimes requires to be covered in the frame for several hours in order to prevent a bluish tint in the portions intended to be white.

One other formula, among hundreds of similar ones, may be here briefly mentioned, although it does not properly belong to boiled soaps:

100 lbs. cocoanut oil at 190° F , into which
50 lbs. talc are stirred; add

112 lbs. soda lye 20° B. When saponified, add
3 lbs. salt, dissolved in
10 lbs, water, and next
40 lbs. water glass, mixed with
10 lbs. soda lye 36° B.

General remarks.

The manufacture of these soaps depends less on the exact formula used than on its proper manipulation, and considerable experience is the most essential feature in making them. According to the proportions of the ingredients employed, a soap will form the mottle more or less rapidly, and the frames must be adapted in size to correspond. Small wooden frames of about 500 lbs. capacity are best adapted for soap which forms a large mottle, and rapidly; such soap is framed at about 145° F., and should contain more salt water in comparison to soap which is run into large iron frames (up to, say 2,500 lbs.,) to form the mottle more slowly. The latter should contain weaker and more carbonated solutions, and less salt water, and may be framed warmer than the quickly mottling soap.

For soaps which are not to yield more than 350% some tallow is used with the cocoanut oil, as this favors the rapid mottling which is necessary when small frames are used.

A MODIFICATION OF ESCHWEGER.

A soap similar in character to the "Eschweger" described, but boiled in a manner approaching nearer to the methods more usual in this country, is made as follows:

The fats are selected and clarified in the same manner as for Eschweger. They are then saponified by running in lye under constant boiling, until the soap acquires a sharp taste which it retains on boiling for a few minutes without the further addition of more lye. (This operation has been fully described in detail in the chapter on White Settled Soap.) More lye is then carefully added in small portions, while boiling, until the soap separates from it. The supply of lye is then cut off and boiling is continued until by evaporation of water a very soft and large grain is formed, from which the lye will settle thoroughly and rapidly.

If on continued boiling the soap remains separated from the lye (indicating that it has all the strength it can absorb), it is allowed rest to settle.

The waste lye contains sufficient strength to require saving it

for some other boil, and it is therefore no disadvantage if—owing to the cocoanut oil—it should contain a little soap in solution, for in that case it will settle the lye most thoroughly; if the soap were grained out too strongly this would prevent the complete removal of the lye, which is very essential, and so much water would be required in the next operation that there would be danger of the soap becoming too thin to hold the coloring matter suspended for mottling; the soap obtained would also be less neutral, and would shrink more on drying. If there should be any indication, therefore, that the waste lye has not settled so perfectly that it can be drawn off entirely, a little cocoanut oil may be added afterwards and boiled through, to absorb the excess of strength.

The lye is then run off, as is also any nigre that may have formed, and the open steam turned on. When the contents of the kettle are again boiling, enough hot water is carefully run in to thicken the soap which is at first thin and stringy, and to form it into a tough, clear mass through which the steam escapes with difficulty. (Instead of simple water a weak solution of silicate of soda (8° B.) may be employed. Up to 50 per cent. silicate solution is sometimes used for such soaps in England.)

It will be observed that the soap is now in a condition practically identical with that of a finished "Eschweger" described, and the quality of lye used, the various signs indicating the proper conditions, and the remedies employed in certain irregularities are also the same.

When the color has then been well incorporated the soap is framed and covered up to form the marble.

CHAPTER X.

Soft (Potash) Soap.

GENERAL REMARKS.

When, instead of the soda, potash only is employed for saponifying the fats, the resulting soap is very much softer than are the hard soda soaps; especially if the stock at the same time consists of the softer oils, in place of the more solid fats rich in stearin, the product will be a soap of about the consistency of lard—a true "soft soap." (There have lately been patented in several countries special methods of making *hard* potash soaps which contain only about 10% of water, but these do not come under our consideration at present).

In this country soft soap is but little used outside of the textile industries, but in most other countries it has an enormous sale also for household purposes, such as cleaning floors and woodwork and for rubbing on clothes in the laundry. Its unequaled solubility and handy form have made it a favorite soap in many places, especially so since the evil smelling fish oil, and also the somewhat less obnoxious linseed oil, which were formerly used largely for soft soap, have been supplanted by cotton seed and other oils which furnish a soap of less unpleasant odor.

Properties of soft soap.

A soap made of oil and potash lye alone is not only the most readily soluble of all, but also the only kind which is perfectly soluble in *cold* water. Owing to this great solubility, its soft consistency, and to the excess of alkaline strength, caustic and carbonated, which it ordinarily contains, it saves much time and labor. Its peculiar value for the treatment of fabrics, and especially woolen goods, has already been pointed out under the heading of "Textile Soaps" (page 139), while it is also well adapted for some toilet purposes, if properly made. As a basis for medicated soaps likewise the soft variety is frequently preferred to hard soap.

The manufacture of a soft soap that answers all the demands of the consumers is in most cases a somewhat complicated matter, for the requirements are numerous and varied, and not always easily made to correspond with that ever present enemy of soap makers—cheapness. Besides the special requirements depending on the class of work to which the soap is to be applied, there are a few general properties which are more or less looked for in every soft soap, as follows: Its consistency and composition must be such that it does not become too liquid in hot weather, so as to run, nor become brittle or freeze in winter; in fact, its composition must be adapted to the season; it must have a good body at all times and yet feel unctuous; it must be "short," so as not to draw threads on removing a portion, but on the other hand it must not be wet and slippery; it should possess a certain degree of transparency and a good color, and—if a figged soap—the grains of potassium stearate must be formed in size to conform to the prevailing taste of the customers. That the production of a soap of these characteristics is an operation requiring considerable attention is evident from the fact that even so apparently trivial a matter as repeatedly taking small quantities of the soap out of a barrel with wet hands is sometimes sufficient to render the remaining soap stringy.

Requirements of soft soap.

The conditions which operate to form a soap answering the above description rest, briefly stated, on the selection of fats of suitable consistency to adapt the soap to the season; on the use of lye containing a proportion of carbonate or other potash salts which, as they do not combine with fat, serve to insure the required shortness; and on the right amount of alkali and water in the soap. In this connection it may be mentioned that soft soaps contain, as a rule, more water than the good qualities of hard soaps, and that a larger quantity of potash is required to form a *neutral* soap with a given amount of oil than would suffice if the alkali used were soda, to say nothing of the excess of alkali which is present in all ordinary soft soaps.

A perfectly neutral compound of oil and pure caustic potash forms a turbid, gummy, sticky mass, which becomes a salable soap only by the further addition of a solution of caustic and carbonated potash. While for a hard soap are required about 100 to 120 lbs. 20° soda lye for every 100 lbs. of stock, there are required for a soft soap 155 to 170 lbs. of (partly carbonated) 23—24° potash lye. Considering furthermore that soft soaps are made

by simply boiling the fats and oils with the lye, without any separation of waste lye and glycerine, it will be seen that the yield of soft soap from a given amount of fat is considerably above that obtained in hard soaps. We shall refer again to the question of yield further on. It is seen from this that the ordinary soft soap differs from hard soaps not only in the nature of the alkali with which it is made, but also in its larger proportion of water and free caustic and carbonated alkali. In fact, soft soap is frequently described as being a neutral soap dissolved in an aqueous solution of caustic and carbonated potash.

Stock for soft soap. As to the stock used, this may be train oil, linseed oil, cotton seed oil, red oil, olive oil, rosin, with or without the addition of tallow or other fats rich in stearin. In winter thin oils are preferred, but in summer the addition of cotton seed oil, tallow, or some other stock forming a more solid soap, is necessary to secure the product from becoming too soft. Train oil, and to a less degree also linseed oil, have the disadvantage of furnishing soap of unpleasant odor which even strong essential oils (mirbane, etc.) fail to disguise effectually. But linseed oil has the advantage of rendering the soap proof against low temperatures if made with pure potash lye; in summer it requires part soda lye, without the aid of which the soap would be too soft in warm weather. Rosin is also much used, especially in brown soap, and gives it a fine, bright appearance. As it makes the soap softer, less should be used in summer than in winter, and a little more soda lye should be used to counteract its tendency to soften the product.

Lye for soft soap. Regarding the lye used in these soaps we refer the reader to Chapter III, and also to the remarks on that subject under "Eschweg" soap, which apply largely to soft soap as well, especially to "figged" soap. In case pure caustic potash be used for making the lye, it will be necessary to add about 26 to 28% of the weight of caustic, more in winter than in summer, of carbonate of potash or chloride of potash toward the end of the boiling, to shorten the soap; but it is preferable in practice to begin with a lye already containing most of the salts from the start, and only adding at the finish the small amount that may still be wanting. In summer some of the potash is substituted by soda, so as to give the soap a greater consistency; too much soda lye, however, or the chlorides of soda and potash, make the soap appear turbid. In hot weather from one-quarter to one-third of soda may be employed in place of an equivalent amount of potash, but allowance must, of course, be

first made for the soda, with which much of the commercial potash is contaminated. If the lye used be too caustic, the soap boils thick and heavily, remaining at the bottom of the kettle instead of rising, and samples of the soap appear tough on running from the paddle, and are of a hard or gummy consistency when cold; in that case some carbonate of potash solution must be added, until the soap runs off the paddle very short (in winter) or draws threads not longer than ½ inch (in summer). On the other hand, if the lye is not caustic enough, so that too much of salts are introduced, the soap boils up very high in the kettle, boils over readily, appears watery, and lacks consistency, so that a sample placed on glass spreads very much. To remedy such a case pure caustic lye and more stock must be added.

Coloring. For coloring soft soaps there are used palm oil (for yellow), rosin or sugar color (for brown), and ultramarine blue or indigo (finely powdered and previously boiled for a considerable time in water and lye) to give a green color.

Filling. Of course, there have also been found ways to fill soft soaps, which may be briefly referred to here: The filling mostly used is a solution of potassium chloride in water (14° B.), of which about 1 lb. is crutched into the cool soap (at 160 to 170° F.) for every 5 lbs. of stock used. Another favorite material is potato flour, rice flour, or starch, because the same bind considerable water and lye and thereby make the soap more solid, which may be even of advantage in hot weather; but at the same time the soap will be less clear and transparent when filled with flour. In combination with silicate of soda, starch is used in a manner as follows: Equal weights of starch, silicate of soda, and water are well stirred together; enough of the soap is then crutched in to make a creamy mixture, of which the desired quantity is crutched into the soap in the kettle. After adding this filling the soap has lost its "short" character, and requires the careful addition of some strong caustic lye (30° B.). *Silicate of potash*, diluted with water, is another suitable filling material for soft soap of which (at 18° B.) 25 lbs. may be used for every 100 lbs. of stock employed. Most fillers render the soap shorter, so that the latter should be made from the start with rather caustic lye, in order to have the right consistency after filling. Besides the materials just mentioned there are also used carbonate of soda (and of potash), and sulphate of soda. The peculiar action of soda salts on potash soap has been previously explained. (See also Appendix, Note 11.)

On the effect of rosin, the different lyes, and the yield of soap (without filling), a German writer made the following interesting observations: Rosin. Yield of soap.

"It may be called a rare occurrence for a soapmaker to obtain the same percentage of yield in making several boils of one kind of soft soap. In a great majority of cases, even with the same fats and lyes, a difference amounting to several per cent. will be noticed. The principal cause of this difference is the impossibility of adjusting with mathematical correctness the evaporation of water by boiling; what is ordinarily termed "normal" evaporation fluctuates between limits which account for these variations. If the evaporation of water by boiling is sufficient in itself to bring about this result, it is still further explained on considering that the yield is affected also by the fats, by the greater or less causticity of the lye, and by the addition of soda in soap for summer use.

"Among the unfilled soft soaps in which potash lye exclusively has been used, the "natural grain" (figged) soaps are prominent, in making which potash lye only is used in all seasons. The different fats selected for the different seasons do not influence the yield to a degree worth mentioning, as it is not so much the tallow but especially the oils which vary. Generally one-third tallow (figured on the total of fats) is sufficient, as, for instance, in summer sufficient stearin for the proper formation of the grain is introduced by the increased proportion of cotton seed oil employed. The yield of linseed oil and of cotton seed oil may be assumed to be the same; the change in the proportions of these two oils used therefore has no practical influence on the amount of soap produced.

"The variations frequently enough encountered in the yield of these soaps generally fluctuate between 235 and 240. This is owing principally on account of stronger evaporation of water in the case of the lower figure named, for in these soaps especially the manufacturer is careful to add potash solution if necessary to counterbalance great causticity in the lye.

"The proper degree of evaporation is recognized in such soaps by observing the froth on the surface toward the end of the boiling. When the soap, having been properly made with caustic and carbonated lye, falls in the kettle during strong boiling, this is the sign that the excess of water is removed and that boiling must be discontinued shortly after. If no formation of froth is then observed on the surface when the soap has quieted down, we are

justified in assuming that the soap was boiled down too strongly. (These remarks are based on boiling over an open fire, the excessive evaporation of water being here caused by either not drawing the fire soon enough, or by after-heating by the heat in the furnace, etc.) In this case the yield would probably fall short of 240 per cent., and in fact there is no clue as to how much water has been unnecessarily evaporated; it is then necessary for the proper yield to add so much water during slow boiling until a very little speck of froth—about the size of a 5-cent piece—is seen on the surface. This affords a certainty that the proportion of water is neither too high nor too low; still there will be small variations in the weight as frequently more or less froth is caused, which, however, does not influence the quality of the soap and therefore requires no correction if the variation is not too far from the normal condition.

"Greater differences in the yield occur in the unfilled ordinary smooth and green soaps (Crown soaps), this being a natural consequence of the changes in the proportions of rosin used and in the lyes employed. The yield of soap decreases in proportion as more soda lye is used, as less soda is necessary to saponify the oil than is required of potash. Soft soaps made of pure potash lye show a larger increase, for in a case requiring 56 parts potash lye for saponification, 40 parts of soda lye of the same strength and causticity would be quite sufficient. Then the character of the lye plays an important part in the yield. Of a very caustic lye less is, of course, required to saturate the oils than of one containing more carbonated alkali, for it is the caustic lye alone which saponifies oils, while the action of the carbonated alkali is purely mechanical and by its presence naturally increases the yield.

"According to season the smooth and green soft soaps contain more or less rosin. The yield is in these cases figured on the basis of the fats alone, because on account of its low price the rosin is considered as belonging rather to the filling than to the fats.

"One would think that the lye required for saponifying the rosin would add to the yield of soap in the same proportion as in pure oil soap, but when the rosin is boiled together with the oils from the start, it rarely causes an increase above its own weight, compared to the soap made without rosin. For example 1,500 lbs. linseed oil and 225 lbs. rosin (15%), without using any soda lye, furnished, according to repeated weighings in actual practice, 3,600

lbs. soap; this is 240%, figured on the 1,500 lbs. of oil. The same result was obtained when 1,200 lbs. linseed oil, 300 lbs. cotton seed oil, and 225 lbs. rosin were used. Only once a percentage of 242% could be recorded. If now a pure oil soap, (without rosin and soda lye) is considered as yielding 228%, then the 1,500 lbs. of oil would yield 3,420 lbs. of soap, and if we add to this merely the simple weight of rosin we have 3,645 lbs. or 243% against 240% actually yielded. The explanation of this deficiency can only be found in the stronger boiling down required for soaps containing rosin. The indications showing when enough water has been evaporated are the same in soap made with rosin as in those without rosin, but in the former they appear later, thereby causing the lower yield.

"Several boils with 10% rosin, made without soda lye, gave a yield of 236 per cent. The materials were 1,250 lbs. linseed oil, 250 lbs. cotton seed oil, 150 lbs. rosin.

"The same soaps with only 5% rosin, made in the same manner, yielded from 230 to 232%. Small variations occur here also, because the lyes are never quite alike, nor is the degree of evaporation.

"The yield of summer soaps, as already said, depends on the use of soda lye. In this respect the use of the cheaper cotton seed oil is of advantage, for with the addition of but little soda a sufficiently solid soap results, together with a larger yield. In the very hot season cotton seed oil may be used almost entirely for smooth soft soaps, when of course the soda lye must be entirely omitted. In less warm weather half linseed oil and half cotton seed oil with 5 to 10% rosin, may be used, but it may then be well to use from 8 to 10% of soda lye to guard the soap against becoming too thin. The loss in the yield with so little soda lye will not be more than two or three per cent.

"In calculating the yield in the case of filled soaps it is only necessary to subtract the weight of filling used and divide the weight of actual soap by the weight of the oils used, to get the percentage of yield. For instance, if 1,250 lbs. linseed oil, 250 lbs. cotton seed oil, and 150 lbs. rosin, with the aid of 380 lbs. chloride of potash solution, make 3,920 lbs. of soap; then there are 3,540 lbs. of real soap, and this divided by 15 (1,500 lbs. of oils) =236%."

THE BOILING.

Boiling by steam.

The boiling is carried out either in a steam-jacketed kettle or by the aid of closed and open steam pipes. Toward the finish a considerable degree of heat is required, for which reason the use of closed steam alone would require considerable pressure in the boiler. At all events, the kettle must be placed as near as possible to the boiler, so as to avoid the cooling of the steam while it is conducted from the boiler to the kettle. In other countries an open fire is used almost exclusively, but this is very liable to burn the soap.

The manufacturing process of soft soaps is almost as varied as in the case of hard soaps. If rosin is used, it may be melted with the oil and both saponified together, or the rosin is added with the necessary lye of 30° B., after saponifying the oil, and the whole boiled together. The proportion of rosin in any soft soap should not exceed 1 lb. to 10 lbs. of stock. The lye may contain the necessary carbonate from the start, or it may be caustic and the soap shortened afterward with pearl ash and chloride of potash solution, as said before.

Other points of variation will appear from the following description of the processes adopted for different soaps.

CROWN SOAPS.

"Crown soap" is one of the many names by which those soft soaps are known which are homogeneous throughout, as distinguished from the "figged" soaps, which have numerous small crystals of stearin soap distributed throughout the mass.

The lye is made either by dissolving commercial caustic potash in water or by causticizing the carbonate. The first-named method is the easiest and safest, as it makes a more uniform lye.

Causticizing potash.

The causticizing of carbonate of potash is done as follows: The potash is dissolved in water, by means of heat, until it shows 20° B. For every 2 lbs. potash there is then added about 1 lb. of freshly-slaked lime and the whole boiled for an hour, when the lime is allowed to settle until the lye can be drawn off clear. The precipitate is heated again, with more water, to make lye of about 12° B. A third washing (anything less than 10° B.) is reserved to be used instead of water for dissolving the next batch of alkali. As the potash and the lime are of ever-varying degree of purity, this process of making the lye is liable to prove troublesome in the

boiling of the soap, especially to the inexperienced soap-maker. For making a purer lye, the potash may be dissolved at first to form a 40° B. solution, from which the impurities are settled out, the foreign salts crystallizing out and settling to the bottom or attaching themselves to the sides of the vessel. The purified solution is then diluted to 20° B. and causticized as above.

As to quantity, there are required about 36 lbs. of pearl ash (causticized by lime), or in other words, about 160 lbs. 24° B. lye for 100 lbs. of stock. Of low-grade potash, or when the soap is to be filled, somewhat more is required.

The stock for these soaps may be linseed oil, cotton seed oil, red oil, and grease, in proportions to suit the manufacturer, and the season, and of course also rosin, if desired. With much linseed oil about 1 part soda lye may be used with every 2 parts potash lye in summer; the more grease is used, the less soda lye is admissible. In winter the soda lye is omitted altogether. The stock may be run into the kettle on the evening previous to boiling the soap, together with say 40 lbs. of lye for every 100 lbs. of stock, and well mixed. Not much more lye, however, must be taken for this purpose, as otherwise the soap may set in the kettle. Nor must the materials be mixed too warm or the spontaneous development of heat might cause boiling over. If the lye had been made by dissolving a pure grade of caustic potash, and it is intended not to add the required carbonate until the finish, and to boil with open steam, the lye may be used from the start at a strength of 20–24° B., but if the lye had been made by causticizing the carbonate in the soap factory (and therefore contains the carbonate intended to be in the soap), and if it were intended to boil over an open fire, the weakest lye obtained in causticizing (10–12° B.) must be used at first, using the stronger lye as saponification progresses. In other words, the strength of the lye is regulated in accordance with its caustic strength and with the amount of water required, so as to avoid the necessity of evaporating much water at the finish. The materials begin to combine over night, and next morning steam is turned on. When the contents of the kettle come to a boil, the remaining lye is run in gradually, under constant boiling, so as to be all in the kettle at the end of about one hour. During this time the soap must not be allowed to become weak, to prevent bunching. The soap now soon becomes clear, indicating that the stock is fairly well saponified. Small samples are then set on glass, to see if the soap has all the necessary characteristics of a well-

Stock.

made soft soap. The sample will probably be thin, and on touching it with the finger it will draw a thread; on cooling it will lose its transparency, and be jelly-like in consistency; on the surface of the soap in the kettle there may be a light scum. These signs indicate that there is an excess of water which must be evaporated in order to "shorten" the soap, by boiling for a while longer. If the sample is not clear, and is slippery on the glass, it shows an excess of strength, which can only be remedied by adding more stock. If the sample is clear at first, but becomes gray in the centre on cooling, lye is wanting.

Signs of proper finish.

The soap which is finished correctly appears as follows: While boiling, it suddenly falls in the kettle, the water having evaporated just sufficiently to shorten it enough; the soap in the kettle is clear, with very little or no froth on the surface, and the boiling mass opens in "roses" similarly as described under Eschweg soap. A heaped sample on glass does not spread very much and shows few air bubbles; touched with the finger it draws no thread, but merely forms a very small point; it is clear, and on cooling becomes surrounded by a very narrow grayish rim of lye, and covered with a fine striped skin. (This latter appearance is termed "lye flower" by the German soap makers, and is the result of the evaporation of water from the hot sample, by which the latter appears as if evaporated too far.) In the summer the soap should be made less strong, and the sample should therefore have this striped appearance less strongly developed than in winter, when a little extra strength protects the soap against freezing.

If the samples have the required appearance, the soap is finished—unless rosin is to be added, in which case it is broken fine, thrown into the soap, and boiled, together with the necessary quantity of 30° soda lye, until the appearance of a sample, as before, indicates that it is finished.

The soap is allowed to cool in the kettle to 150° F. and then run into barrels, and crutched until cold.

FIGGED SOAPS.

By appropriate manipulation soft soap can be made so that in course of storing it for a time it develops numerous crystals of stearate of potash throughout the mass, ranging in size from that of a pin-head to that of a grain of rice, giving it a "figged"

appearance much liked by consumers. This process of crystallizing is analogous to the formation of the mottle in hard soaps, but requires longer time, taking from two to six weeks. It is brought about, in the first place, by the addition to the stock of some fat rich in stearin, such as tallow, for the formation of the grain; for the clear body of the soap oil is used. The lye used is potash altogether, without the addition of any soda lye, and even the potash should be as free from soda as possible, as the latter prevents the formation of the crystals. Furthermore the lye for figged soap requires to be still less caustic than that for the "Crown" soaps, as the soap must possess, even when cold, the necessary mobility to permit the crystals of potassium stearate to form. The more tallow or other solid fat is used, the thicker will be the soap, and the more carbonate must consequently be in the lye. If the lye is too caustic, the soap will remain perfectly homogeneous in storing, instead of crystallizing. On the other hand, if it contains too much carbonate it crystallizes very readily, but also becomes syrup-like on storing.

The lye is made as described before for other soft soaps, or the lime is slaked in weak lye that may be on hand, and the potash dissolved in the latter. About 40 to 42 lbs. of lime are required for 100 lbs. of pearl ash; a little more in summer.

Stock. The stock may be: Linseed oil or cotton seed oil, 65 parts; tallow, 35 parts; or, tallow, 40 parts, linseed oil, 40 parts, and cotton seed oil, 20 parts; or any similar combination. For yellow soap some palm oil may be added. The stock should be fresh, if possible; old rancid tallow requires to be previously purified. A greater proportion of tallow than just named causes smaller, but more abundant crystals.

The stock is saponified as described for the ordinary soft soaps, and boiling must not be carried too far, as an excessive evaporation of water retards, if it does not entirely prevent the crystallization, besides reducing the yield. The signs for a finished soap are similar, as already described under "Crown Soaps." When it sinks in the kettle while boiling, and on shutting off steam, only a small speck of froth is seen in the center of the surface, it contains the proper proportion of water. The soap may be known to have the right alkaline strength when a sample, almost as soon as it is set on glass, has a slightly turbid surface. The cold sample must be clear, with this slight turbidity barely perceptible; but

after a short time it should no longer be bright, but rather appear covered with a bloom such as is often seen on ripe fruit.

When cooled in the kettle to 150° F., the soap is run into dry and clean barrels, which are stored in a cellar, at a temperature between 55° and 65° F., which is most favorable for crystallization. Other things being equal, this process will take less time as the proportion of tallow used is larger.

Filling. For filling figged soaps silicate of potash is best adapted, as soda prevents in a measure the proper crystallization. The filling may be added in the following manner: Mix silicate of potash in warm water till the solution shows 11½° B. while warm; then add 38-40° potash solution to bring the strength up to 13½° B. warm. Into 435 lbs. of this solution crutch 300 lbs. of flour. Enough of the soap is then added to form a tough mass, which must draw long threads on removing a small portion. This mass is then crutched into the soap in the kettle, when some caustic lye of 27° B. must be added to restore the proper strength and consistency. The proportions used are about as follows:

2,350 lbs. soap.
300 lbs. flour.
435 lbs. silicate solution.
535 lbs. lye, 27° B.

The soap to be filled should not contain too much carbonate, as the filling will shorten it to some extent. In winter less silicate and more carbonate is preferable.

ARTIFICIALLY FIGGED SOAP.

The crystals of potassium stearate being produced by the use of tallow or similar fats, which are comparatively cheap in this country, there is scarcely any need of causing the same appearance by artificial means, as is a very common practice in countries where tallow is very high in price compared to other stock. But in highly filled soaps also the crystals are often represented artificially. This is done—to the detriment of the quality of the soap, of course—by breaking well-burned lime into very small pieces, and sifting those out which pass easily through a coarse sieve, but do not go through a sieve of say sixteen meshes to an inch; these small pieces of lime are crutched into the hot soap and swell up in the same by absorbing water, making a very close imitation of the naturally figged soap. Chalk is sometimes similarly used, but is less satisfactory, and artificial grains of various kinds are even an article of commerce.

CHAPTER XI.

General Remarks on Boiling Soaps.

The chapters VII., VIII. and IX. have been devoted to a description of the methods employed in this country for boiling the hard soaps used in the laundry and for general household purposes; the operations of perfuming, pressing and reworking of scraps will be described in separate chapters, as will also the boiling of toilet soap for milling.

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Artificial marble. A special variety of marbled soap, which also contains a large proportion of water, may be made by cooling a boiled soap just enough to bring it to the consistency required to keep the coloring matter suspended. When the coloring matters are then crutched in, the marble is formed in a manner similar to that observed in soap thickened by boiling down.

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Various processes. There have been invented numerous devices and methods with a view to improve the ordinary boiling process, such as boiling the fats under strong pressure with carbonated alkali, boiling with superheated steam, etc. It is very unlikely, however, that a great change will ever be generally adopted from the present ordinary boiling process, for, as said before, it is difficult to imagine anything more simple. The only direction in which real improvements are to be looked for is in the mechanical appliances used for the various requirements of the soap factory, and possibly in the employment of new raw materials.

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Simplified processes. The manipulations described in the preceding chapters, if properly carried out, will furnish excellent products in each case. It is true that not all soaps are boiled as carefully and with as

many "changes" as here described, but the simplified processes never give as good results. Nor will it be necessary to describe in detail the various short cuts by which two or more operations are sometimes condensed into one, for there is nothing mysterious about the boiling of soap, and whoever desires to do so can readily determine how to abbreviate the making of any soap by carefully considering the reasons stated why each operation is conducted just as it is. For instance, a careful perusal of the chapter on Settled Rosin Soap will suggest that such a soap *could* be made by saponifying the tallow and rosin in one operation, thereby saving one change; then an excess of strong lye could be used instead of salt (or brine) for graining the soap, thereby saving the strengthening change also; the soap could then be thinned for settling directly after running off the lye used to grain the soap.

Or, if this is not simple enough yet, the tallow and rosin could be saponified with just enough lye to leave the soap very nearly neutral, and then the latter could be thinned directly for settling.

These and other suggestions will readily occur to the practical soap maker, who will also understand their disadvantages. For this reason they have not been treated at length in these pages.

We repeat, there is no mystery about the boiling of soap, but an intelligent understanding of *all* the raw materials, fats, lyes, salts, and of the "reasons why" of *all* the different operations is required, in order to come to correct conclusions in determining the course to pursue in given cases. For this reason these pages have been devoted to explanations rather than to hard and fast, but unexplained formulas, *which the uninitiated could no more follow* than the average human being could steer a ship across the ocean, had he ever so high priced maps to guide him.

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Waste Lye.

Formerly much speculation was indulged in as to the best method of "regenerating" partly spent lyes, so as to bring them into proper condition for using them over again. At present they are either worked up for glycerine, if from the first change, or their remaining strength is utilized by boiling with fats and fatty acids, to recover the strength of the carbonate as well as the caustic soda.

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Yield of hard soaps.

The weight of soap yielded by a given amount of a certain fat or rosin is a matter of practical importance; but owing to the

various kinds and *qualities* of materials used a positive answer that will hold in all cases cannot be given to this problem. One lot of tallow or other fats, or of rosin, will turn out differently than others; besides the proportion of water present in the finished product is not always the same. (A moderate amount of water must be present in every hard soap, besides the fatty acid and alkali, and is therefore included in the yield. Filling of any kind is, of course, not included in speaking of the yield of actual soap). The increase consists of alkali and a moderate proportion of water —less the glycerine lost—and of course is somewhat higher in settled soap than in boiled down soap. There is also considerable difficulty in ascertaining the exact yield in a given case, from the fact that in a large boil on a manufacturing scale it is next to impossible to accurately weigh all the fat and rosin used, the good soap obtained less the filling that has been added before framing, and the good soap still contained in the nigre.

It is therefore generally considered sufficient to estimate that "100 lbs. tallow, saponified with soda lye, yield about 150 lbs. of soap; rosin increases slightly less than tallow; cocoanut oil yields somewhat more."

An experiment on a small scale would permit of more accurate observation, but it is impossible to say just how near the results are to those actually obtained in the factory. The details of such an experimental boil recently made by Mr. C. Melzer, and reported by him to the *American Soap Journal*, are of interest in this connection; the following is an extract of the essential parts of the same:

"The quantities operated with were 10 pounds 74 per cent. Solvay caustic soda, 25 pounds prime tallow, and 25 pounds K rosin. The 10 pounds caustic soda made 67 pounds lye of 20° B. at 60° Fahr. To saponify the 25 pounds tallow I required 26 pounds of the 20° lye and produced 42¾ pounds curd soap. The waste lye which was very slightly alkaline marking 12° B. at 60° Fahr. Without removing this waste lye I added to this soap in kettle the 25 pounds K rosin, used 23½ pounds of the 20° lye for saponifying the same, and grained out with a little more salt. The total soap now weighed 81¾ pounds, showing that the 25 pounds rosin had produced 39 pounds. The very dark-colored waste lye now marked 14° B. at 60° Fahr. and contained alkaline strength which I estimated equal to 1 or 1½ pounds of 20° lye, thus leav-

ing 22 or 22½ pounds 20° lye actually required for saponifying the 25 pounds rosin.

"The appearance and general properties of this 100 per cent. rosin-soap correspond to the old-fashioned boiled-down rosin soap of ante-bellum times of which it was said that it answered equally well for washing the clothes and for rosining the bow. Next, I settled this soap in the usual way, and after a repose of four hours dipped out 49 pounds settled soap. There were probably two or three pounds more, but this could not be dipped out without getting more or less nigre also. This settled soap is of good color and filled with 7 per cent. 33° Carb. soda solution (1 ℔. 58 per cent. Solvay Process Co. "Pure Alkali" (Carb. Soda) make 3½ ℔s solution of 33° at 120° Fahr.) looks all right, but, of course, is quite sticky. Adding salt brine to the nigre I boiled it down to a sharp grain which weighed 34¾ ℔s. The waste lye weighing 15° B. at 60° Fahr. remaining clear and had very little alkaline strength. Of course this weight of settled soap and nigre is disproportionate, the settling operation on so small a scale being imperfect. In practice the nigre is much smaller, varying from one-fifth to one-third of the total. It will be noticed that the combined weight of settled soap and nigre is two pounds greater than that of the curd soap previous to settling, which difference represents the extra water held in the settled soap.

"Why we should be able in an experiment like this to produce a larger quantity of soap with a smaller quantity of soda than in actual practice I cannot explain, unless it is that in the experiment we *know* the quality and quantity of the materials and of the product, whilst in actual practice we do not. In the experiment referred to, I used at the rate of 14½ ℔s. 74 per cent. caustic soda to saponify 100 ℔s. of stock consisting of equal parts tallow and rosin; in actual practice the proportion of rosin as compared to the fats is about 50 rosin to 100 fats, and if these figures are taken as a basis, it will be found that I used just about 15 ℔s. 74 per cent. caustic soda to the 100 ℔s of stock. According to the law of equivalents this is more than enough; and whilst I do not wish to prove my figures in this way, I shall hold that they are about correct until convinced of the contrary by other means than the results supposed to be obtained in actual practice."

Referring to calculating the yield in actual practice the same writer remarks:

"The manufacture of commercial soap is not an exact science; we may say that the acids and bases employed in soap making will only combine in fixed proportions according to their equivalents, and any surplus of one or the other will not enter into the combination no matter what the soap maker may do. That is all good enough, but the practical soap maker does not aim to produce a neutral salt, that is, not generally. To attempt to tell, from accounts kept in the factory, in any but an approximate way, how much of this and that material was used, and how much soap was produced therefrom, is impossible. I keep accounts of every batch of soap made in our factory, but make no pretense to their correctness other than that they show the probable quantity of fats and rosin consumed and the number of frames of soap produced.

"I will here quote from my kettle book the debits and credits of six successive batches of soap, which will show about as correct results as is possible to obtain in this way.

"The first two of these six batches of soap were made in clean kettles (kettles Nos. 2 and 3); on the nigres remaining therefrom two more batches of the same (high grade) soap were made, then the nigre in No. 3 was pumped into the nigre in No. 2, and some stock added, and this made into a batch of second grade soap; after this the nigre in No. 2 was pumped into a nigre in kettle No. 1 remaining from a previous batch of low grade soap, stock added and worked again into a batch of low grade soap. The nigre now remaining in kettle No. 1 may be considered an offset to the nigre previously in this kettle, and as I work up no soap trimminge in our kettles there is nothing to estimate in this direction.

"The aggregate quantity of fats (tallow, white and yellow grease) used for these six batches, was 130,500 pounds, rosin 44,500 pounds; soap produced, 292 frames. Our frames are 48 x 42 x 15 inches and considered to hold 1,100 pounds of soap. I have never weighed one, and it is not convenient to do so, but taking the average of the quantity of soap we cut out of a frame, and adding to this the weight of the trimmings, 1,075 ℔s. appears to be about right, and I take this weight as the basis: 292 frames of 1,075 ℔s. = 313,900 ℔s. of soap, and deducting from this 36,500 ℔s. of carbonate of soda, etc., added in the crutcher (the et cetera represents the perfume), we have 277,400 ℔s. soap produced from 175,000 ℔s. stock consisting of fat and rosin in the proportion of 100 fat to 34 rosin, or an increase of 58½%. This does not show up so well as in the experiment, and in looking for

the probable cause, I find the following, which in a measure applies to our factory only, but corresponding causes may and probably do exist in every other factory. In the first place, our fats are pumped into the kettles from reservoirs supplied with a gauge similar to those on railroad watering tanks, each division on this gauge representing 1,000 lbs. of fat. Taking for granted that these gauges are correct with the fat at a certain temperature, say 110° Fahr., then the fats would always have to be measured when at this temperature or the necessary correction made if taken at a different temperature. This is not the insignificant matter it seems to be, for fats and oils are expanded more by heat than liquids in general, and based upon the figures given by Deite (Handbuch der Seifenfabrikation, page 11) the difference in the volume of 25,000 lbs. fats or oils differing 36° Fahr. in temperature, would be equal to about 500 lbs. This correction, however, is never made. A still more important item is the impurities and water held in suspension by the fats.

"Several months ago, I worked up a lot of grease stearin which contained a very considerable amount of albuminous matter, but this could not be readily separated, except from the spent lye of the soap, and very recently we bought white grease that looked wet, but precipitated no water on being melted; a moisture determination, however, showed that it contains over 19%. This grease is of peculiar nature and origin, but as it is not likely that the readers of the *Journal* will have any of it to deal with, I will not mention it further. With rosin it is even worse; there is opaque rosin and trashy rosin, and rosin of which we do not know whether it will increase 30 or 60%; it is even difficult to get at the exact weight. We weigh or average the barrels and deduct 40 lbs. for Alabama or 70 lbs. for Savannah cooperage, and when we come to a dark or trashy barrel, the whole, or such part as is bad, is thrown out and the estimated quantity deducted, or it is not. This may look like great carelessness to the theorist, but he would very probably do the same way if he were engaged in the manufacture of commercial soap on a reasonably large scale."

The exact quantity of alkali required for saponifying a given amount of fat is a question which is of greater importance in making soap by the cold or half-boiled process than in boiling. During the latter the soap-maker can determine when more lye is required, and can also readily see when an excess is present and remove the same from the mass; he is, therefore, content to use

as much alkali as the fat can possibly absorb, as this increases his yield of soap. The quality of the stock is too variable to calculate with sufficient accuracy in advance the amount of alkali a large boil will absorb. In the cold and half-boiled process, however, the calculation is made as near as possible, since in this case there is no other way than to mix the lye with the fat in proportions estimated to be correct.

* * * * * * * *

Framing. The temperature at which a soap is framed is of importance in most cases. Apart from the filling operations in the crutcher, as described under "settled soap," the temperature also affects the behavior of the soap in the frames. A pure (unfilled) soap, cooling slowly in the kettle, will assume a different formation and texture than one poured hot into the frames (where it cools more rapidly than it would in the kettle), because in the two cases the crystallization of the stearin soap from the olein soap will proceed differently. This difference is noticed even between large and small frames. A soap which in a 3,000-lbs. frame, for instance, shows a small crystalline formation and dries in straight lines after cutting, will have a large grain if run into a 6,000 lbs. frame, and will perhaps dry crooked after being cut into bars. This is a subject which must be studied in regard to each special soap made.

CHAPTER XII.

Half-Boiled Soaps.*

GENERAL REMARKS.

The manufacture of soap by half-boiling consists, briefly, in mixing the melted stock with lye, either (preferably) in the crutcher or in the soap frame. The lye is used quite strong (say 35° B.) and the temperature of the stock may be taken at about 140° F. from the start, so that it will rise to 180-200° when the reaction of the lye on the stock causes the spontaneous generation of additional heat. Others use the fat just warm enough at first to melt it, mix it with the lye, and when the ingredients begin to combine turn on steam in the jacket of the crutcher to raise the temperature to say 180° F. or over (according to stock, etc,), keeping it at about that point till the soap is of uniform consistency. This latter process has the disadvantage that it may easily cause the soap to boil over unless carefully watched, and that a jacket crutcher or a water bath must be used, while the proceeding first mentioned permits of the use of an ordinary crutcher and, as already stated, may even be carried out in the soap frame. In case stock containing much free fatty acid is employed, the reaction is so rapid that much heat is quickly evolved, so that in such case the stock should be used at a somewhat lower temperature; it is preferable, Methods of half-boiling.

*The term "half-boiled" soap is not applied by all soap makers to signify the same thing. Mostly it is employed to designate those soaps which are made without actually boiling the ingredients, but are formed at a higher temperature than that used for the "cold-made" soaps to be described in the next chapter. We shall employ the term in this sense in this treatise. (Others include in the denomination "half-boiled" all hard soap—other than cold—made without change of lye, and which therefore contain all the glycerine and impurities of the stock. This definition would therefore include the "Eschweg" soap already described in Chapter IX.)

however, to remove the free fatty acids beforehand by preparing the stock as for cold-made soap.

Advantages and disadvantages of half-boiling.

It will be readily understood that the action of the lye on the stock is necessarily less complete in this case than in the process of making soap by boiling, and that the product will naturally contain some uncombined ingredients, besides all the impurities that may have been present in the stock and lye, and the glycerine formed by the chemical action. But, on the other hand, this process permits of remedying defects which may appear in the course of manufacture, which is not the case in the cold process, to which it is therefore superior. The soap will also be somewhat imperfect on account of the impossibility of calculating exactly the amount of lye to be used for a given amount of stock; however, the half-boiling process is in this respect preferable to the cold process, since it is possible to make necessary corrections when making soap by half-boiling, if towards the finish there is either a lack or an excess of strength apparent.

Purity of stock.

The purification of the stock being of special importance, the treatment with lye as described for bleaching tallow (page 42) is applicable for all kinds of stock for this purpose; or any of the other bleaching processes mentioned in the description of various fats and oils might be used, if preferred. The lye treatment is indicated, also, for the removal of free fatty acids from the stock, as the presence of these interferes with the proper saponification in all cases where actual boiling is not employed. In the process of bleaching those impurities are removed whose presence is especially objectionable as tending to impair the keeping property of the soap.

Lye.

The lye used for half-boiled soap should be as caustic as possible; in other words, should be made from the highest grade of caustic, as the presence of foreign salts in the lye is an obstacle to the proper combination of fat and lye. (Compare also the remarks on this subject under "Cold-Made Soaps.")

Prepared silicate.

If silicate is used in the soap, care must be taken that the same has sufficient alkaline strength. Ordinarily to every 100 lbs. silicate 25-30 lbs. of 35° lye must be added, in order to prevent the silicate from crystallizing in the soap, from lack of strength. To properly prepare the silicate for this purpose the lye is added until its presence is perceptible to the taste, then just enough silicate is added till the taste of the lye disappears again; prepared in this manner the silicate will not spoil the appearance of the finished

soap by crystallizing or coming to the surface; nor is it so likely to cause soft and spongy parts in the middle of the frame, as unprepared silicate is very apt to do. If preferred, the silicate may be mixed at the start with the lye required for a batch of soap, and sufficient of that lye be used for both fat and silicate.

Crutching.

The soap being generally of a very dense consistency, owing to the low temperature employed, the crutcher should be arranged to run slowly when used for the half-boiling process, and stirring should be continued only as long as necessary; to attain this object it is desirable to have the crutcher connected with a separate engine, whose speed can at all times be adapted to the requirements of the crutcher. Or, where this is not possible, the cog-wheels on the crutcher (or the pulleys on the counter shaft) must be arranged so as to give a slow speed to the machine. When half-boiled soap is crutched fast or too long it is apt to become spongy and floating by the incorporation of air bubbles.

For the same reason those crutchers which have a screw and center tube (see Fig. 25-30) should be filled sufficiently to have the latter covered at least with two or three inches of soap, so that in falling over the edge of the center tube the contents cannot catch air. The size of the frames should correspond with the capacity of the crutching machine, when the latter is filled as indicated ; or if the frames are not large enough the center tube of the crutcher will have to be cut down sufficiently. The crutcher should always be heated somewhat before running in any of the stock, as this not only guards against undue cooling off, but also prevents the soap from sticking to the sides and causing lumps in the mass. It is also a convenient arrangement to connect the steam pipe which leads to the jacket with a cold water pipe, to be used in case the oil should be too hot at any time. This cold water connection is also very useful because, by applying cold water in the jacket in time, as soon as signs of rising are noticed, boiling over may be prevented which is otherwise very liable to occur at times. (See Fig. 21).

Amount of lye used.

Particular attention must be paid to using the correct amount of lye required to saponify the stock for a batch of half-boiled soap. An excess of lye will make the soap too sharp ; if not enough lye is used part of the fat remains unsaponified, the soap will be smeary and soft and, if the miscalculation is considerable, the soap in the crutcher will be so thick that it is almost impossible to get it out for framing. As to the proper amount to be used, variations

occur, owing to differences in the stock, to the grade of caustic, and to the purpose for which the soap is to be used, washing soaps made by half-boiling or by the cold process being frequently made intentionally so as to have a very slight excess of strength. (See also the remarks on this subject in the chapter on cold-made soaps.)

In calculating the amount of lye necessary, the figures named in the chapter on the cold process may be used as a basis; but it must be remembered that a more perfect combination results from half-boiling, for which reason *from 2 to 3 per cent. more lye may be used in it* than for the cold process. Of a very pure lye, and for average stock, about 335 lbs. of 35° B. soda lye may be calculated for 600 lbs. of tallow and similar fat; only for cocoanut oil about 355 lbs. are required. As said before, if this amount is found to leave the soap either too weak or too sharp, it is an easy matter to make the necessary correction in the crutcher before framing.

Pearl ash solution.

Strong pearl ash solution it sometimes added to the mass in the crutcher from the start, as it renders the soap more liquid and better to work; it also improves the texture of the product by giving it a finer grain, but as it does not combine with fats the finished soap will contain free carbonated alkali. To avoid this in a soap intended for toilet purposes, it is more to be recommended that some of the caustic soda lye be substituted by caustic potash lye, instead of using the pearl ash solution.

Strength of lye.

Regarding the proper strength of the lye for half boiled soap, 35° is in most cases best adapted. Tallow, cotton seed oil and olive oil, however, if worked with only a small addition of cocoanut oil, make a smoother soap when the lye is reduced to 30-33° B. As it is a great convenience in some cases to know about how much water is required to reduce a certain amount of lye of a given strength to one of the weaker degree, we give the following example of such a calculation, which will answer in cases where the lye is to be diluted only by a few degrees:

Diluting lye.

Supposing our lye is 39°, and we want to use 350 lbs. lye at 35°; how much lye and how much water must we take? ANSWER: $350 \times 35 = 12{,}250$ lbs. °; divided by the degrees of our lye: $39 \div 12{,}250 = 314$. There are therefore required 314 lbs. of 39° lye and the balance (36 lbs.) of water. This calculation is not absolutely correct, but sufficiently so for most purposes when the lye is to be diluted only by a few degrees.

White soap.

If the soap made is to be white, a trace of ultramarine blue is frequently added. whereby the naturally yellow tint is changed

into a less noticeable greenish color. The addition of some potash or sal soda solution will also make the soap appear whiter, but at the same time make it more brittle and alkaline. If starch, silex or any similar fillers are to be used, they are mixed with the oil before running it into the crutcher and the mixture strained into the latter to avoid lumps. If, in cases of extremely high filling, the oil cannot hold all this extra material without thickening too much, some of it must be added to the lye (except the starch, which would form a stiff paste and not work well). Filling.

If many batches of soap are to be made, requiring many successive weighings of fats and lye, it is best to have two scales, with a sheet iron pan each, provided with a faucet near the bottom to empty it. The fat is run into one of the pans, weighed, and the faucet opened to let the stock run into the crutcher; the lye is then similarly weighed, etc., on the other scale. When only one scale and one pan are used the weight of the latter is increased with every weighing, owing to the remnants of fat and lye, which will partly saponify and remain behind on emptying the pan, thus giving rise to errors in weighing. The particles of soap are also liable to stop up the faucet. Weighing the stock.

The process of making soap by half-boiling resembling the cold process in many particulars, some further useful hints may be found in the chapter describing the latter, to which the reader is referred. Similarity to the cold process.

HALF-BOILED WHITE SOAP.

To make a white soap by half-boiling, proceed as follows, observing at the same time the preceding "General Remarks":

The fat may consist of any suitable combination, such as, tallow 4 parts, cocoanut oil 1 part, cotton seed oil 1 to 3 parts, clarified in the manner referred to before. The amount of lye is calculated with reference to the nature of the stock used, in accordance with the figures just given. If silicate is to be added also, it must be prepared with lye, as already stated. The fats are used at a temperature of 140° F., and the lye at the ordinary temperature of the atmosphere in summer; in cold weather the lye should be brought to a luke warm temperature. The silicate is first crutched in, and then the lye. (Or, if preferred, the silicate may be previously mixed with lye, as already explained.) The mixture is now allowed to stand for 1 to 1½ hours, until it is observed to ecome heated by the action of the lye on the fat. Then the

crutching machine is started *slowly*, and if the soap shows (by its taste) a deficient alkaline strength, a few pounds of lye, diluted to 10° B., are added, so that the desired strength is attained. Strong lye should not be used for this purpose, as it would cause the formation of lumps. If, on the other hand, the soap is observed to be too strong, a little cocoanut oil must be added. These additions, however, must never be made until the mass has been standing in the crutcher *at least* 10 to 15 minutes after the machine was started up. Different stock does not combine with the same rapidity, which must also be taken into consideration.

Using weak lye for correction.

Crutching after framing.

When the materials have combined into a homogeneous mass, the soap is run into the frame and stirred by hand for 15 to 20 minutes, in order to avoid the formation of streaks. This is a rule which applies to all smooth soaps made by half-boiling.

A somewhat different soap results from the following slightly changed proceeding and different stock:

Tallow	440 lbs.
Cocoanut Oil	60 lbs.
Soda Lye, 34° B.	220 lbs.
Potash Lye, 30° B.	60 lbs.

The fat is heated to 125° F. and the lye worked in; the crutcher is covered, and in 1 to 1½ hours the mass will become heated by the chemical union of the ingredients. If necessary to do so, steam is then very carefully turned on to bring the heat to about 180° F. and retain it at that point for some time, until the soap is uniformly clear and well formed, when it is run into the frames.

HALF-BOILED SOAP FOR MILLING.

Although the soap for milling purposes is made in most cases by boiling, the half-boiling—and even the cold process—are occasionally employed, although they are less to be recommended for this class of soaps than for any other. A soap of this kind may be made of about eight parts of tallow and two parts cocoanut oil, treated in the same manner as just described for a white soap. Another suitable combination is:

350 lbs.	tallow,
200 "	cocoanut oil,
50 "	castor oil,
300 "	lye, 38° B., diluted with
26 "	water.

As milled soap, more than any other, is expected by the consumer to be well made and to retain its fine appearance and odor for a long time, it is necessary to observe every possible precaution to secure the most thorough saponification possible. If an appreciable proportion of unsaponified fat remains, the soap will soon turn rancid, acquire a dirty color and a rank odor. On the other hand, a milled soap is expected to be also free from uncombined alkali, and an excess of strength is, therefore, to be avoided with the same degree of care. While it is not possible to manufacture a faultless piece of soap, except by careful boiling, a salable and for many consumers quite useful milled soap may be prepared by half-boiling.

As a means to promote the combination, a solution of sugar in water is sometimes added to the soap, which thins it out somewhat and helps to bring it into a condition favorable to more complete combination.

The process of milling itself will be described in a separate chapter.

HALF-BOILED MOTTLED SOAP.

The manufacture of a mottled soap in the crutcher is not entirely satisfactory. However, as it may be profitable in some cases, we give herewith the points to be observed. The soap must be made neutral, and resembles in most particulars the Eschweg soap described in chapter IX., but, owing to the lower temperature, the tests there given for the proper finish are of no use in a half-boiled soap.

The materials used may be as follows:

500 lbs. tallow,
100 " cocoanut oil,
100 " cotton seed oil,
410 " lye, 34 or 34½° B.

The stock to be of a temperature of 150° F. It is necessary to leave the soap, when it seems to be finished, in the crutcher for at least 15 to 20 minutes longer, as it might happen that the soap is deficient in lye; it would then become weak in the frame, although it may have appeared just right in the crutcher, unless lye is added as soon as it is observed that, on standing in the crutcher, all the strength has disappeared.

After saponification a solution is added consisting of 8-10 lbs.

salt and 6–8 lbs potash in 50 lbs. of water, the desired color having been mixed in the brine. The frames must be well covered until the mottle forms. Silicate—prepared with lye—and other fillers may be used. (Compare also "Eschweger III." page 189).

HALF-BOILED FLOATING SOAP.

This may be made of tallow (or grease) and a small proportion of cocoanut oil. The batch is made of such a size only that the center tube in the crutcher is above the surface of the soap so as to cause the soap falling over the rim to catch air in crutching. The stock should be at about 120° F., and no steam is admitted into the jacket after saponification has set in. After crutching briskly until a sample taken out is quite light, and swims on water when cold, the soap is framed and allowed to cool as quickly as possible, that it may retain the air bubbles evenly throughout the frame. If the soap is made too warm, it will settle in the frame and will not float after pressing. (Mineral soap stock and some silicate might be used for filling, but are not to be recommended in this class of soaps).

Soap made by half boiling, of stock containing ½ or more of cocoanut oil, is difficult to make so that it will not float, as its consistency is such that it will retain any air that may be crutched into the mass.

In this soap particularly the lye should be as caustic as possible, and care must be taken not to make the soap too thin.

ROSIN SOAP BY HALF-BOILING.

When a rosin soap is to be made by the half-boiling process the rosin is melted together with an equal amount of tallow, strained, and weighed in with the other stock. The temperature of the stock must not be above 130° F., for rosin saponifies more quickly and causes greater heating in combining with the lye than does oil. With a higher temperature than 130° F. on the start the soap is liable to become so hot that it would rise out of the crutcher, and the part not spilled would be spongy and floating. A rosin soap made by the half-boiling process will take all kinds of filling, the same and even better than a settled rosin soap, if made with lye of from 30–35° B., and will give from 157 to 165 lbs. soap from 100 lbs. stock, without the filling. The addition of a little palm oil will improve the color.

(See also formulas in chapter on the cold process).

TAR SOAP BY HALF-BOILING.

Weigh the stock into the crutcher, and use not over one-tenth to one-sixth tar, because a greater quantity would make the soap soft and color the lather. According as the stock is more or less hard, use the lye at 36 or 37° B. The stock may consist of say 250 lbs. cocoanut oil, 250 lbs. tallow, 50 to 100 lbs. tar, and 275 lbs. lye at 36° B. The materials will join in ¾ to 1 hour. The temperature at first should be as low as possible, and care must be taken not to use tar admixed with water, as is often the case. After the materials have joined they should be left in the crutcher for 15 to 25 minutes, as the stock saponifies unequally and the soap might prove sharp to the taste for some time; if stock were then added to take out this strength the soap might prove weak and too soft in the frame. If preferred, the soap may be made in the ordinary way and the tar crutched in when the soap has been well formed.

FILLED HALF-BOILED SOAP.

(Specially suitable for Laundry Chips.)

315 lbs. tallow.
55 lbs. cocoanut oil.
40 lbs. mineral soap stock.
185 lbs. silicate of soda.
30 lbs. 32° B. potash solution.
280 lbs. 35° lye.

Warm the stock to 140° B. and add the lye as in the other soaps described. When the soap is in the frame, crutch it till it is quite thick.

HALF-BOILED COCOANUT OIL SOAP.

A pure cocoanut oil soap may be made by half boiling in the manner described in the preceding pages. As has been stated already on various occasions, this oil lends itself more than any other for filling with various salt solutions, without causing the soap to become soft, especially if an excess of lye be also used. Such soaps are of course not to be recommended, as they are wasteful in use and injurious to the skin; but since there is a market for soaps of this kind, at prices at which better products cannot be furnished, the manufacturer is often practically compelled to make them.

We append the following receipt as an example:

Cocoanut oil	300 lbs.
Soda lye 34° B	225 lbs.
Potash	60 lbs.
Salt	40 lbs.
Soda ash	20 lbs.
Water	385 lbs.

The water is heated and a portion of it used to dissolve the potash and soda ash ; the remainder is used to moisten the salt. About two-thirds of the lye are crutched into the oil, and when the ingredients combine some of the hot water is added. When the mass is uniform, the soda and potash solutions are added alternately, in small portions. The salt is next added, and then the remaining one-third of the lye. The temperature of the soap must, during the whole operation, be maintained at 190 to 195° F. When all is incorporated, the soap is covered up for two hours. At the end of this time, if there is any froth on the surface, a little more water is required. If small samples taken out are too hard or too sharp, a little oil mixed with some hot water is crutched in.

The amount of filling which such soaps will absorb, in the form of various salt solutions, is almost unlimited, but they naturally dry out considerably on aging.

The above process is highly recommended by some soapmakers of the old school, but it should be added that the soap will turn out fully as well made if a good, pure soap is made first, and the filling added only when the soap proper has been finished.

TRANSPARENT SOAPS.

These are made very largely by half-boiling, but will be described in a separate chapter.

CHAPTER XIII.

Cold-Made Soap.

ADVANTAGES AND DISADVANTAGES OF THE COLD PROCESS.

As was explained in Chapter VI., the "Cold Process" of making soap consists in intimately mixing with each other certain proportions of the fats or oils and strong lye, at about the melting temperature of the stock, and then running the mixture into the frames to work out its transformation into soap by itself, with the aid of the heat generated spontaneously by the action of the ingredients on each other. As the chemical action progresses, the mass rises in temperature, until at last the fat and lye have combined, when chemical action gradually becomes less energetic and at last ceases altogether; the heat disappears slowly, and at the same time the soap formed hardens in consequence of the lowering of the temperature. It is seen that no separation of waste lye takes place in this process, and cold-made soap, therefore, contains—like half-boiled soap—all the impurities that may have been introduced with the stock, all the water used for making the lye, the foreign salts that may have been contained in the caustic, the glycerine formed during the formation of the soap, and also more or less of the raw materials in an uncombined state. The cold process is applied chiefly to the manufacture of laundry soap and of the cheapest grades of toilet soap, and sometimes also to soft soap. As it resembles in many particulars the half-boiling process described in the preceding chapter, the reader is referred to the same for additional details.

As may be readily supposed, a method of manufacturing soap, so different from the boiling process, has certain advantages as well as disadvantages of its own, and according to various conditions and circumstances a factory may find it advantageous to make all

its soap by boiling, or all without boiling, or it may use both processes for different products.

Many of the smaller factories which work by the cold process exclusively, undoubtedly did so in the first place because a comparatively small outlay was sufficient to buy the necessary plant for making soap without boiling; and once having established their special brands, these factories generally find it neither convenient nor advisable to change their products by adopting new manufacturing methods. A mixing vessel with suitable stirring apparatus, a lye tank, a few soap frames, a furnace for melting the stock, a press to finish the cakes, and a few smaller implements, these constitute the machinery required with which alone, if necessary, a soap factory on the cold process can be, and frequently has been, started.

Another reason why the cold process exclusively is employed by some factories, is the fact that small quantities of soap can be very conveniently made by it. The boiling of soap requires apparatus, labor, and time, which are too expensive to apply except for a fairly large batch, to say nothing of the practical impossibility of properly finishing a small batch of soap by boiling. In connection with this there is the further advantage that by the cold process a batch of soap can be turned out on very short notice, and certainly much more rapidly than by boiling.

Again, while experience and good judgment are certainly required to make a *good* soap by the cold process, it is at the same time easier to acquire a certain knack of making a passable piece of soap in the cold way, than it is to learn the art of soap boiling; probably this fact has also had a tendency to make the cold process a favorite with many smaller factories that are being established from time to time in towns growing at some distance from the larger cities.

But, as mentioned before, there are also numerous factories making large quantities of soap by boiling which nevertheless use the cold process for certain of their brands, showing that there are still other reasons for making cold-made soap besides those just mentioned, depending on the properties of the product itself. Among these a prominent one is the fact that cold-made soap, *while fresh*, has a better appearance than almost any boiled soap, which is owing partly to its amorphous texture that causes the cakes to preserve their square outline form for a longer time, instead of warping, like cakes of boiled soap. Their color also, if

carefully made, is generally more beautiful. In general appearance a fresh, cold-made soap resembles a milled soap more closely than do the boiled soaps (but owing to its amorphous texture it has not the peculiar mark on the ends of the cake which milled soaps, and to a less extent also most boiled soaps, acquire in pressing). On aging, however, cold-made soap sweats readily, dries up, and then has a much less beautiful appearance than a boiled soap of the same age will possess. The length of time during which a cold-made soap will preserve its fine appearance depends partly on the care used in manufacturing it, on the amount and kind of filling used, and on the nature of the stock, cocoanut oil soap being less changeable in this respect than that made of tallow, grease, etc.

The most important disadvantage under which cold-made soap labors, is the impossibility of securing a perfect combination of the fat and lye, so that no free fat and alkali will remain present. Apart from the impossibility of calculating the exact proportion of lye which a given amount of fat will require in order to form a neutral soap, it is also beyond the power of the cold process to combine all of the materials perfectly, even if the right proportions were used. There will consequently, under all circumstances, remain some free fat and some free alkali in the soap, causing sharpness and sweating on one hand, and (later on) rancidity on the other. In this repect the half-boiled process gives better results, although not equal to those of boiling.

A peculiarity of cold-made soap is that it washes away more rapidly than boiled soap made from the same stock; it consequently lathers more freely and may perhaps be appropriately compared in this respect to floating soaps.

SELECTION OF THE STOCK.

When the cold process was first employed for soap making the lyes were still universally made by causticizing carbonate of soda in the soap factory; the resulting lye was rich in carbonated soda and other salts which are incapable of combining chemically with neutral fats, and as a consequence the lye and the stock would not combine with each other to form salable soap, unless a large proportion of cocoanut oil was used with. it. It thus came to be accepted as a rule that cold-made soap could only be made by using at least from one-third to one-half cocoanut oil in the stock. At present, however, where high grade lyes are as easily made as

those of lower grade the cold process can be employed for all kinds of stock, even without any cocoanut oil at all if so desired.

The selection of the fats most appropriate for a soap of certain characteristics is the same as for boiled soaps, with the difference only that, along with the other considerations, a naturally somewhat readier solubility of cold-made soaps must not be overlooked.

For some cold-made toilet soaps cocoanut oil alone is used, and these readily produce an exceedingly abundant lather, owing to the naturally great solubility of cocoanut oil soap; it therefore washes away rapidly, and a delicate skin cannot bear its constant use, as such a soap acts too energetically, for the reason just given.

Of the several varieties of cocoanut oil the Cochin oil is preferred for the cold process, especially for making white soaps, as it is the whitest, usually the freshest, and produces a soap which has less of the peculiar odor characteristic of cocoanut oil soaps; it also gives the product a better appearance, both for white and colored soap. However, its quality varies considerably in different shipments, as is also the case with Ceylon oil, which sometimes contains so much free fatty acids that the soap thickens up before all the lye can be stirred in. This difficulty is overcome by purifying the oil, as described further on, and also in the chapter on fats and oils. But in factories where any other use can be made of such stock it is better to employ only the freshest cocoanut oil for the cold process, although it should be clarified under all circumstances.

Next to cocoanut oil in value for cold-made soap is tallow, which is used in the stock in all desired proportions. When no cocoanut oil at all is used, as is the case for making what is known as "Soap Chips" for laundry purposes, it is advisable to add some softer material to the tallow, such as grease, cotton seed oil, etc. In fact, the before-mentioned rule applies here as well, that it is always best to use several kinds of stock together, so as to take advantage of the good qualities of each, and to counterbalance the bad ones. In some cases the addition of a small proportion of castor oil is advisable, as it causes the product to possess greater transparency and an improved texture resembling that of milled soap, and greater durability of the colors and perfumes. The presence of a small proportion of castor oil is also useful in working up the scraps, as it facilitates the process of remelting; or, if the scraps are utilized by milling, the result of the presence of castor oil is an improved texture of the milled article. When first

made, a soap containing castor oil is a little softened by it, but it soon hardens.

A material sometimes worked up in this connection is the flower pomades used by the perfumers. When most of their odor has been extracted, they may be made into a delicately perfumed soap by the cold process. But this stock deteriorates rapidly, owing to the influence of the alcohol used in extracting the odor, and is then very difficult to work by the cold process, owing to the free fatty acids present.

For further details concerning the selection of stock the reader is referred to the description of different fats and oils (Chapter II), and to the special chapter (VI) covering this subject.

PURITY OF THE STOCK.

After selecting the kinds of fats according to the well-known properties of the soap which they form with alkali, the purity of the same is of the greatest importance, much more so for making cold-made soap than when they are saponified by boiling. All impurities of the fat must, therefore, have been removed before adding the lye, so that the soap maker may know just what material he has to deal with, and in order that the soap itself may be pure. All fats may be purified before use, in the manner described elsewhere, but if very old they should be excluded altogether in making soap by the cold process, as even purification fails to give good results in that case.

As a preliminary step, melting the stock and resting it in a settling tank (as described under "Saponifying the Fat," in Settled Soap, Chapter VII), is to be highly recommended, also, in the cold process, for the purpose of removing the coarser impurities. The extent of the impurities removed thereby can hardly be realized unless the stock is weighed before as well as after settling.

Besides the direct loss from very impure or adulterated stock, and the strongly alkaline soap apt to result from it, there is danger of a batch being spoiled altogether in case the fat contains such impurities as salt, water, sulphuric acid (from rendering), etc., in appreciable quantities.

No less important is the absence of free fatty acids from the stock. If old and unprepared fats are used in the cold process, the free acids combine very rapidly with the lye, and in doing so collect in lumps of partly formed soap, enclosing in their mass

particles of fat which are thereby prevented from combining with the lye; as a result the product in such a case will be a poor soap, full of uncombined materials, quickly turning rancid, losing its perfume, and appearing smeary and yet sharp at the same time. In making soap under such conditions, the contents of the mixing vessel thicken up quickly, sometimes even before all the lye can be mixed in, and the resulting soap has a coarse texture, whereas a well-made, fine-grained soap results only when the mass is in a condition permitting it to be stirred or crutched for some length of time. Even if the consequences are not always so very noticeable, the soap made from fat containing free fatty acids will always be gritty and coarse-grained, and of generally inferior quality.

In order to make uniformly good soap by the cold process, it is therefore always necessary not only to free the stock from all foreign impurities, but also from the free fatty acids, an operation so much the more to be recommended as it also bleaches the stock at the same time, and thus causes a marked improvement in the color and clearness of the product, besides improving its quality as a detergent.

The purification and bleaching of all kinds of stock for the cold process may be performed by treating the melted fat with a little strong lye and alum and agitating, as described on page 42 for bleaching tallow. If preferred the following process may be adopted instead:

The stock after melting and settling or straining, is run into any convenient vessel and brought to a temperature somewhat below 180° F. For every 100 lbs. of stock 2 or 3 lbs. of 36° lye are then run in slowly and stirred in thoroughly for several minutes. The lye will combine with the free fatty acids and the particles of soap forming will enclose and carry with them the other impurities of the stock. After stirring for a few minutes as stated, 2 or 3 lbs. of 22° salt water are run in and stirred through. The vessel is then covered up (unless the atmosphere is very warm) and the contents are allowed to rest over night for the separation of the impurities. The stock should not be warmer than 180° F. because otherwise the impurities will remain suspended in the oil.

When, especially for laundry soap, it should be deemed unnecessary at any time to subject the stock to a special process of purification, the temperature of the stock should be as low as possible when running in the lye; even if at first the soap shows signs of slightly congealing, the heat gradually liquefies it again

and the soap may be finished without trouble. This proceeding will produce a finer grain than when the stock is comparatively warm.

For cocoanut oil it is always advisable, however, to at least boil it up on strong salt water for half an hour, taking off the scum which rises until it comes up perfectly white. At this point the impurities are allowed to settle.

QUALITY OF THE LYE.

The quality of the lye that is used for making a soap by the cold process is of considerable consequence, and in fact as important in a cold soap as in soft soap, Eschweg soap, or in any other soap that is made without a change of lye. It is in cold-made and in half-boiled soaps more than in any other that one can appreciate the force of the definition which explains that soap is "lye. diluted and modified by fatty matters." But unlike the lyes used for Eschweg and soft soaps, that employed for the cold process is very simply determined: it is at all times to be made of the highest grade of caustic that can be obtained.

76 to 77% caustic, dissolved in soft water (preferably that condensed from the steam pipes, or rain water), protected from the atmosphere by an airtight covering, and allowed to rest till all impurities have settled out, makes the best possible lye for this purpose. Only when customers demand a very white looking soap, **White soap.** can a lye of low-grade soda be used to advantage, to which—for cocoanut oil soap—some salt may even be added. Soap made with such lye is really inferior in quality, but it is sometimes demanded by customers who judge the product by the color.

The lower grades of caustic contain impurities in the form of salts, especially carbonate of soda and common salt, which are not in any way affected by the fats, and, if the lye is made from such caustic, these salts remain unchanged as impurities in the soap, besides causing imperfect saponification by preventing the caustic alkali more or less from coming into that intimate contact with the particles of fat, which is necessary for their chemical combination. A lye containing much carbonate of soda causes the soap made with it by the cold process to be soft and spongy, and under otherwise unfavorable circumstances may even losen the combination between alkali and fat to such an extent, that the fat will partly separate and collect in the centre of the soap frame, where the

soap is the hottest. The same is true with silicate of soda (unless used in large quantity), and when a moderate proportion of the latter is used for filling, the soap will have to be run into small frames, so as not to retain too much heat. Besides causing the faulty saponification, the foreign salts have the disagreeable property—especially in winter—of coming to the surface of the soap with the water, on drying, and remaining behind as a dry, white crust when the water evaporates. This makes the soap unsightly, ruins the wrappers, and has a suspicious appearance to the mind of the consumer.

To make the lye, the caustic should be dissolved, as said before, in pure, soft water. If only hard water can be obtained it would be well at least to boil it and let it settle, as thereby a part of the lime compound held in solution by hard waters is precipitated. Or the water may be softened by adding 2 or 3 lbs. of caustic soda to 1000 gallons of water, and letting it settle. A convenient tank for this purpose is one that has a faucet at the bottom for drawing off the sediment, and another one a few inches from the bottom, for the clear water or lye. When made, the lye should be at a strength of about 35° B. when hot, which will bring it to 38—39° when cold. It can then be diluted further, if wanted, without becoming hot again. If the lye when first made is above 39—40° it will become hot again on diluting it, which is generally best to avoid, as warm lye makes less smooth soap.

After the caustic has been dissolved, the lye should be excluded from the air, as the latter always contains carbonic acid, which the caustic alkali absorbs eagerly, thereby becoming partly carbonated, and consequently reduced in purity and strength in a similar way as if it had been made originally from low-grade caustic. A simple method of protecting the lye in this respect, by means of mineral soap stock, was mentioned in the description of the lye tank, on page 79.

Where the facilities are such that this can be done, the lye should be made early enough to give it several days' time to clarify by resting, and drawn off carefully from the settled impurities. If an occasion should arise when it seems desirable to filter the lye, this may be done by the aid of glass wool, packed into a glass funnel.

Some brands of caustic, especially the lower grades, occasionally furnish a lye of a yellowish tint. For white soaps such lye is not well adapted, as their color is extremely delicate. The color

of such lye may be removed by boiling it with 30 lbs. quick lime to each drum of caustic, and letting settle.

As in all soaps, the substitution of a part of the soda lye by potash lye causes a marked improvement in the product of the cold process, as it renders the product milder, better in texture, more readily lathering, and slightly more transparent at the edges. Care must, of course, be taken to get good potash. As more potash is required than soda to saponify a given amount of fat, 7 lbs. of potash lye are generally used in place of 5 lbs. of soda lye.

QUANTITY AND STRENGTH OF LYE.

The exact amount of alkali required for the saponification of a certain amount of fat has been a matter of considerable speculation and finespun scientific calculations, but all the latter have been able to do was to prove that for practical work no absolutely correct figures can be set down, as fats are too variable in their composition and purity. Figures that are correct for a certain weight of, say a given lot of tallow, are not necessarily correct for the same weight of some other lot of tallow. Then again, so long as the cold process cannot insure the *perfect* combination of all the lye with all the fat, there would really not be much advantage even in knowing the figures representing the exact chemical equivalents, for what the soap maker must strive for is to so gauge the proportions of lye and fat as to make a soap as near as possible in accordance with our conception of an ideal soap. If we must needs employ the cold process for our purpose, then the question is not what proportions would give the best results *if* they could be combined, but the question is: "What proportion actually does give the best total results?"

Some manufacturers, knowing that a certain weight of lye will make a mild soap, deliberately use a slight excess in order to have a product for the laundry or for general housework that will wash quickly. For toilet soaps, of course, the case is somewhat different, and the manufacturer must keep within narrower limits. Under the circumstances we can give only approximate figures which are known to give good results under careful manipulation, and state under what conditions, as to strength of lye, etc., the alkali is best employed.

Cocoanut oil requires more alkali for neutralization than any other known fat, and for a toilet soap made by the cold process it

is universally calculated to require just one-half of its own weight of soda lye, if the latter is of 38° B. strength and made of 76% caustic. If the caustic soda is of a lower grade than 76% then correspondingly more must be used (or the lye is made of about 40° B.). If it is desired to use a weaker lye the quantity of 38° lye necessary may simply be diluted as much as desired. For tallow, grease, lard, etc., half their weight of soda lye at 36° B. is generally accepted as the proper proportion, they all requiring about the same amount of alkali.

For 50 lbs. cocoanut oil and 50 lbs. tallow there are, in a similar manner, calculated 50 lbs. of 37° lye of 76% caustic soda.

It will be observed that these amounts are slightly below those named for the half-boiled process, which is owing to the fact that in the latter more can be used, as the combination is more complete.

Too much lye makes the soap not only sharp, but also excessively rough, hard and brittle. Small batches of soap do not develop as much heat as larger ones; they therefore do not combine as thoroughly, and are apt to be somewhat sharper than larger batches made of the same proportions of material.

An unfilled soap, made of 600 lbs. stock and 300 lbs. of 38° lye, will have about 25% of water in its composition; for 100 lbs. caustic and 200 lbs. water make 300 lbs. lye of about 38° B., and these, with 600 lbs. of stock, make 900 lbs. of soap.

Regarding the strength of lye, cocoanut oil and cotton seed oil saponify most readily with that of 38°, but for the other fats it is best to reduce it to 36° B. If the lye used is too strong the saponification of the fat will be less thorough, and the soap will be hard and rough as if an excess of lye had been used. For white cocoanut oil soaps which are to preserve their color for some length of time it may be well to reduce the strength of the lye with water to 36°; the soap will be somewhat softer at first and is therefore hardened by the addition of a little extra lye. This proceeding insures a better saponification and consequently guards the soap against rancidity. To keep the extra water from drying out a small addition of chloride of potash solution at a strength of 15° B. is sometimes also made, or part of the lye used is made of caustic potash.

In some formulas the strength of the lye is given, with directions to dilute it with a certain amount of water. This is done because it is more convenient, and at the same time more exact,

to use a certain amount of lye of ordinary strength and dilute it afterward as required, than to dilute it to a certain degree, to be determined by the hydrometer; the greater convenience is obvious, and the greater exactness follows from the fact that a lye shows slightly different densities, according to whether it is measured just after diluting and stirring it, or after resting for some time.

TEMPERATURE OF STOCK FOR MIXING.

The fats must be melted, so as to be in condition to mix thoroughly with the lye, and for the sake of economy in time, labor, and fuel, the stock is preferably used when it has cooled off enough after bleaching it. Cocoanut oil is therefore best melted and prepared at least a day previous to using it; or before, if the quantity is large, so as to give it time to settle and cool. Tallow settles more rapidly and is ready almost immediately after bleaching, except for its high temperature; with the other stock already cooled, if both tallow and cocoanut oil are used after settling, the average temperature may be about right. If for any reason it can not be arranged to have the stock cool off naturally, it will be necessary to cool it by means of cold water, either by leading the latter through a coil placed in the settling tank, or by circulating cold water in the jacket of the vessel in which the soap is to be mixed.

Cocoanut oil alone may be saponified to the best advantage when cooled to about 70-80° F.; a mixture of equal parts, tallow and cocoanut oil, at 100-110° F.; tallow, lard, grease, etc., when used alone, at 105-130° F., according to their age, etc. Only a slightly higher temperature is required than would be necessary to keep the stock from solidifying on running in the cold lye, so that the proper temperature depends on the melting points of the fats. In winter it is best to have the stock about 10° F. hotter than in summer, and to have the lye at about 80° F.

If the stock has not been prepared, *i. e.*, the free fatty acids removed, or if rosin is used with the stock, it is necessary to use the lowest possible temperature, as the free acids cause considerable spontaneous heating by their rapid combination with the lye.

If the temperature at which the ingredients are mixed is too high, those particles of the fat which were first to come into contact with the lye combine with the latter so rapidly that lumps

form before all the lye is thoroughly mixed in, and, these lumps adhering to each other in a mass, the whole batch may be spoiled.

It is also worth remembering that a low temperature produces a whiter soap, while a higher temperature is more favorable for a certain degree of transparency in the product.

The lye is used in nearly all cases at the ordinary temperature of the atmosphere, except in cold weather or for old stock, when it is made luke-warm. Some prefer to have both, stock and lye at the same degree, but it is difficult to see any advantage accruing from the trouble of heating up the lye under ordinary circumstances. On the contrary, a cold lye rather favors a greater smoothness in the finished soap.

MIXING AND SAPONIFICATION.

The actual saponification takes place only during the course of spontaneous development of heat in the frame, and is barely induced while mixing. The stock, at the average temperature best suited to its composition—as just explained—is run into the mixing machine. This machine may be any vessel provided with a suitable agitating apparatus, and consists preferably of a jacketed kettle with a rapidly revolving agitator; the crutching machines described in chapter V. are very suitable for the purpose.

The object of this machine being simply to mix the fat and lye as thoroughly as possible, the best results are obtained by having the machine run at a good speed so as to complete the mixing quickly and keep the contents as homogeneous as possible while the lye is running in. For making colored soap, from well-purified stock, so as to admit of long crutching, an ordinary vessel and a hand crutch are frequently preferred, as it is difficult to clean a crutcher from the remnants of the colored soap.

The stock being run into the crutcher (which should not be perfectly cold in winter time), the machine is started to crutch and the lye is run into the fat steadily in a thin stream at such a rate that it is all added in three or four minutes for a large batch. Crutching is continued uninterruptedly until the mass is observed to thicken, so that a mark drawn on the surface remains visible for some time and a sample taken out on a paddle runs off slowly and forms thick threads on the surface of the soap. Crutching is then discontinued and the soap run at once into a frame placed under the machine. Some experience is required to judge correctly just

when a soap of a given composition as to stock is in the best condition for framing; if framed too early the soap will afterwards be found smeary in the upper part and very sharp near the bottom of the frame, owing to part of the lye sinking. On the other hand, if the crutching is continued too long, or if too much time is allowed to pass before framing, the mass may separate in the frame and spoil the batch altogether; the same may happen if the ingredients were either too cold or too hot, or impure.

Another proceeding which is preferred by some, although it is difficult to see any advantage in it, consists in adding only about one-half of the lye at first; when the contents of the crutcher form a homogeneous mass the remainder of the lye is then added.

The length of time necessary for crutching varies greatly, but the longer the stirring can be continued before the mass shows signs of requiring framing the finer will the grain of the soap become; in this respect also purified fats have an advantage over those not previously purified, as the former do not combine so rapidly with the lye.

The frame into which the soap is run should not be too cold; nor should it be very high, especially if it is of large capacity, as it would retain too much heat. If the soap is run into a rather large flat frame and covered up with sacks or blankets it will become heated by the action of the ingredients on each other, and saponification will be effected without any further attention being required. In very hot weather cold made soaps—especially those highly filled—are liable to separate oil in the frame if covered up too warm; the temperature which a batch is allowed to acquire is therefore of much influence on the quality of the product and requires some study for each special case to obtain the best results. A soap of a certain composition which turns out well in a 300-℔. frame would be likely to show signs of separating oil in a 600-℔. frame, and would spoil entirely in a 1,200-℔. frame, owing to the greater heat prevailing in the larger batches.

When the heat has ceased to be generated in a frame, the soap may be uncovered in order to cool off more quickly; after then hardening for a day or two it is ready to be stripped. In iron frames it must remain covered longer than in wooden ones which retain the heat longer; if uncovered too early the soap in the frame is apt to be of a different color in the centre than on the sides.

A mixing machine has been patented which can be lowered into a frame so as to mix the ingredients therein, using no special

mixing vessel. Ordinarily, however, some of the machines described in Chapter V. are used.

FILLING.

Cold-made soaps may be filled with any of the materials enumerated and described in Chapter IV., by making the additions in the manner described for half-boiled soaps. Mineral soap stock, silicate of soda, and talc, are the fillers most commonly employed. The *silicate of soda* must be prepared with lye in the same manner as described for half-boiled soaps, or an equivalent excess of lye must be used with it. Such soap has a very nice appearance while fresh, but on drying out somewhat acquires a hard surface. As stated before, silicate, especially if it has not been previously prepared with lye is liable to cause separation, or spongy parts in the centre of the frame if the batch is large, so that for such soap it may be necessary to employ frames holding as little as 200 lbs. each, and let the frames remain uncovered. When much silicate is used, however, the frames may be larger, probably owing to the fact that a larger addition tends to decrease the development of heat, by retarding the combination. The silicate, if added to the mass when the materials have joined, would thicken the soap so much that it could scarcely be handled; it is therefore generally mixed with the lye before stirring the latter into the fat, or it is mixed with the last portion of the lye used. A little glycerine or some 15° pearl ash solution is sometimes used in addition to make such soap a little smoother. *Talc*, which *may* be used in as large a proportion as 25 or 30 per cent. and over, gives the soap a somewhat dull appearance, in white as well as in colored soaps, but it also makes it less hard on aging than one containing silicate with which it is sometimes used together; some manufacturers prefer to boil the talc in a little weak lye before adding it, claiming that this "opens" the talc and makes the product smoother. Others prefer to simply mix the talc with the oil before running the lye into the crutcher.

For cheap soaps made largely of cocoanut oil, solutions of salt, potash, and chloride of potash are largely employed as fillers in Europe, since cocoanut oil has the property of absorbing these solutions in considerable quantities without separating. These solutions are usually crutched in when the soap has thickened so as to be nearly ready for framing, and are mostly employed at a

strength of from 15° to 25° B. Salt water makes the soap hard on drying and causes it to feel moist if added in more than moderate quantities. Chloride of potash is more expensive, but retains the water of the soap better than does common salt. In fact, these fillings must be regarded as simply water, to which the salts are added for the purpose of counteracting the softening effect which simple water has on soap. Potash solution especially prevents the drying of soap filled with salt solution or silicate, so that potash and salt are generally used together; it also gives the soap a more transparent appearance.

In European countries cold-made cocoanut oil soaps are also very frequently filled by so-called filling lyes, which are made according to the following examples, and which are used to the extent of from 10 to 50 lbs. to every 50 lbs. of cocoanut oil in the stock: (1) 100 parts water, 14 parts sugar, 7 parts salt, 7 parts pearl ash. (2) A 16° B. solution of chloride of potash, sal soda and salt (equal amounts of each). (3) One part each of sugar, potash and salt dissolved in 4½ parts of boiling water. (4) 85 parts hot water, 9 parts pearl ash, 6 parts salt, 5 parts sal soda.

In using these filling lyes the cocoanut oil should not be used warmer than necessary, and the frames are not covered, as the soap would become too hot if covered and would separate oil in the centre. The oil and lye are first mixed, and when the soap is thick and appears ready for framing the filling lye is crutched in.

Where these salts are used for filling it is so much more important, of course, that the lye be made of the highest grades of caustic. If, on pressing, the soap should show a tendency to crack, as is liable to be the case when much filling is employed, the cakes must be warmed somewhat to soften them before pressing.

PERFUMING, COLORING, MARBLING

If properly prepared stock is used, the essential oils for perfuming may be crutched into the soap just long enough before framing to secure their intimate admixture, so as to avoid all unnecessary evaporation during the crutching operation, as well as the action of the lye on the oils. With unprepared stock it may be necessary to add the oils together with the last of the lye.

If powdered orris root is added, and it is found to make the soap too dry and brittle, some of the soda lye should be substituted

by potash lye, or the lye is used a little weaker. Orris root turns the color to yellow or yellowish brown. It should also be remembered that oil of cloves has a peculiar composition, different from other essential oils, and that it is therefore not well suited for soaps made by the cold process, as it interferes with the combination of the materials, and at all events gives the soap a bad grain and texture and a yellowish color; the latter case is also true in regard to cassia oil, which makes these two oils unsuitable for white soap. (For further details see the chapter on Perfuming and Coloring.)

Insoluble colors, such as vermilion, are well mixed with a portion of the oil, and added to the stock from the start; soluble colors, such as annatto, aniline, etc., are dissolved in boiling water, or in alcohol, and strained through a silk cloth into the stock or the lye, to avoid specks of undissolved color. Of the soluble colors much smaller quantities are ordinarily required than of the soluble ones.

For yellow soaps a little unbleached palm oil may be used with the other stock. Palm oil in conjunction with orris root and storax causes a natural and *permanent* reddish brown color which makes this combination popular for cold-made violet soap.

White soaps must not be too warm on cutting up the frames, as they are liable to become discolored on exposure to the air when warm. The addition of just a trace of ultramarine will change the yellowish tinge of most white soaps into a less noticeable greenish color.

For making marbled or variegated soap by the cold process, the water soluble colors are not well adapted, as they run too much. Numerous processes are employed to produce the marbled appearance; for instance, the soap may be run into the frame before it has become quite so thick as usual. A sheet iron cylinder, open at both ends, is then sunk into the frame and the soap within colored through the upper end of the cylinder. A wooden stirrer is then used to draw the colored soap into the uncolored portions in streaks, and, lastly, by means of a rod with a round knob on the end, figures are drawn through the whole frame.

Another method consists in mixing the colors with a little oil or warm water and stirring this into a small portion of the soap, when thick. A layer of soap is now run into the frame, and the colored soap is spread over it "criss-cross" in a thin stream (as by running it through the stem of a funnel, or a sprinkling can

with large holes). Then follows another layer of the soap, and again streaks of the colored soaps. When the frame has thus been filled by alternate layers, a stick is used to distribute the color in the soap more finely, as described above.

Where the mixing vessel is such that it can be tipped to empty it into the frame, the soap in the upper part of the vessel only may be colored, and the whole then emptied quickly by tilting the vessel, so as to run both the colored and the uncolored portion out alongside of each other.

Still another method is as follows: The color is mixed with a portion of the soap and a layer of it poured in streaks over the surface of the soap in the frame. It is then forced to the bottom by means of a ⊥ formed crutch, in the bottom piece of which there are a number of holes. Another layer of colored soap is then treated similarly, and so on till all the color is added. A rod is then used to distribute the color still further.

FORMULAS FOR VARIOUS COLD-MADE SOAPS.

Although the preceding pages contain all the necessary information required for building up a formula to make a soap to suit every purpose, a few ready formulas will probably be found useful by way of illustration. The following are selected to show those of the most varied character, and manufacturers who desire to do so can readily modify the same to suit their own requirements by giving due consideration to the effect of different materials and manipulations, as has been fully explained.

PURE COCOANUT OIL SOAP.

300 ℔s. cocoanut oil.
150 " caustic soda lye, 38° B.

This soap lathers very readily, and if carefully prepared Cochin oil and well settled, clear lye are used, the soap will be almost semi-transparent. The lye may be reduced in strength by adding water, until it marks 35-36° B., which will make the soap somewhat smoother and softer; a *small* extra addition of lye will harden it again and will bring about a more complete saponification, so that the soap will preserve its white color longer. By reason of the better saponification this extra strength will not be very noticeable, especially as a pure cocoanut oil soap can be used (for toilet

purposes) only by those whose skin is not very delicate, it being too sharp for tender skins, even if quite neutral.

As the lather is almost too profuse, and the soap wastes away quickly, a small proportion, say 10%, of castor oil may be desirable, as this addition also improves the texture and transparency of the soap.

FILLED COCOANUT OIL SOAP.

The above soap may be filled with silicate, talc, etc., if desired, in accordance with the directions already given for half-boiled soap, and in the special chapter on filling materials. About 60 lbs. of silicate (prepared as previously stated), with or without the further addition of 15 lbs. potash solution might be used; or, if preferred, say 35 lbs. of talc.

COCOANUT OIL SOAP, FILLED WITH SALT SOLUTIONS.

300 lbs. cocoanut oil.
150–160 " soda lye, 38° B.
30–150 " salt solution 18° B.

Or,

300 lbs. cocoanut oil.
150 " lye 39-40° B.
25 " potash solution 20° B.
12 " salt water 16° B.

In the above two formulas the oil is melted (at about 80° F.) and 135 lbs. of the lye crutched in. When the mass is thickening the remainder of the lye, mixed with the salt solutions, is added.

If some castor oil is preferred in the soap, it may be added to the cocoanut oil, and the filling may be varied according to the following formula:

300 lbs. cocoanut oil.
30 " castor oil.
162 " soda lye 38° B.
24 " potash solution 20° B.
18 " potassium chloride solution 15° B.

TALLOW AND COCOANUT OIL SOAP.

240 lbs. cocoanut oil.
160 " tallow.
200 " soda lye 37° B.

The manufacture of this soap is the same as that of the pure cocoanut oil soap described, only the temperature of the stock must be a little higher, say 100° F. The tallow will cause the soap to be less wasteful and to lather less quickly than a pure cocoanut oil soap, and will ordinarily reduce the cost somewhat.

Another formula, in which some potash lye is used, and a little less (½) cocoanut oil, may be adopted, as follows:

250 lbs. cocoanut oil.
250 " tallow.
240 " caustic soda lye 38° B.
10 " potash lye 38° B.

A filled soap which in the eyes of some customers has a better appearance even than the foregoing pure soap, can be made by changing the formula as follows:

240 lbs. cocoanut oil.
160 " tallow.
200 " soda lye 40° B.
60 " potash solution 20° B.
20 " salt water 18° B.

A soap of different character results from the following:

275 lbs. lard.
175 " cocoanut oil.
225 " 36° soda lye.

Or,

100 lbs. cocoanut oil.
50 " tallow.
50 " lard.
50 " castor oil.
120 " 38° soda lye.
5 " 26° potash lye.

Or,

(For yellow soap.)
160 lbs. cocoanut oil.
120 " tallow.
20 " palm oil (unbleached).
150 " soda lye 37° B.

GLYCERINE SOAP.

Some soaps are called glycerine soaps by the manufacturers on the strength of the little glycerine only which forms during the saponification of the fat. There is however, also a class of soaps

to which some extra glycerine is added, which increases the emollient feeling of the soap and preserves it longer against drying out. Too much glycerine, however, causes sweating and makes the soap smeary.

The glycerine is mixed with the melted stock and the mixture saponified in the ordinary manner. If silicate is to be added it may be crutched in after the materials have joined, together with the necessary lye required for preparing the silicate, as the glycerine naturally thins the soap out somewhat. If only little glycerine, or much silicate is used, the latter may be previously mixed with the last of the lye added to prevent the soap from thickening too much.

The following is one of a great number of similar formulas:

120	lbs.	cocoanut oil.
40	"	lard.
40	"	tallow.
40	"	glycerine.
100	"	lye 38° B.

The fats are melted, and the glycerine added. At about 100 to 110° F. the stock is saponified with 100 lbs. 38° lye.

LAUNDRY SOAPS.

The foregoing formulas are principally intended for toilet soaps. For laundry soaps a smaller proportion of cocoanut oil is used, as the latter is expensive, and the soap wastes away too fast. Naturally, no close distinction can be made between soaps for the two purposes, except, of course, so far as perfuming them is concerned; but the following formulas will be found to be better adapted for household soaps than for toilet purposes:

350	lbs.	tallow.
150	"	grease.
100	"	cocoanut oil.
35	"	mineral soap stock.
400–435	"	soda lye 35° B.
300	"	silicate of soda.

The mineral soap stock is melted with the fats, at about 120° F. The silicate is dissolved in the lye, and the latter run into the crutcher while the machine is running briskly. The perfume may be added with the last of the lye. The addition of the lye requires

less than five minutes, and, after crutching for a short time longer, the soap will have acquired the proper consistency for framing.

This formula may, of course, be changed in many ways, as regards stock as well as filling. A formula, for instance, which gives satisfaction in many localities, is as follows:

220 lbs. tallow.
35 " cocoanut oil.
165 " soda lye, 34° B.
125 " silicate of soda.

Still another formula is as follows:

330 lbs. cocoanut oil.
170 " tallow.
250 " soda lye, 39°, diluted with
30 " water.
350 " filling, made by dissolving 2 parts sal soda, 1 part pearl ash, 2½ parts salt, in 20 parts of boiling water.

For soaps of this kind, as before mentioned, small and low frames are the most suitable.

ROSIN SOAP.

As rosin consists of free acids, its presence in the stock causes some difficulty in use for the cold process, as pointed out previously. But this may be overcome fairly well by suitable manipulation. (If desired, the rosin may be purified as described on page 62.)

The following are several formulas which have been used for the purpose:

100 lbs. cocoanut oil.
100 lbs. tallow.
200 lbs. rosin.
200 lbs. lye 39° B.

Or,

100 lbs. cocoanut oil.
100 lbs. tallow.
25 lbs. rosin.
112 lbs. lye 37° B.
20 lbs. talc (stirred into the stock).

Or,

50 lbs.	tallow.
50 "	palm oil.
20 "	rosin.
55 "	lye 40° B.
50 "	silicate of soda.

Or,

255 lbs.	tallow (or bleached palm oil).
45 "	cocoanut oil.
45 "	light rosin.
181 "	38° lye.
181 "	38° silicate of soda.

The fat and rosin are melted together, strained, and saponified, the crutcher running rapidly, and the lye—mixed with the silicate, if any is used—being added slowly; if run in too fast or too warm, the soap will work over. Another method of making these soaps which is capable of giving good results is as follows: Taking the first of the above three formulas as a basis, the stock is melted and worked together with the 150 lbs. of the lye; scraps that are to be worked up may also be added in small pieces, and the whole is melted together. In another vessel the 200 lbs. rosin are melted on 60 lbs. of the lye, and when all the scraps have become melted the rosin mixture is run in slowly while crutching rapidly. The soap must be framed quickly. The lye may have to be diluted somewhat, owing to the dryness of the scraps and the water evaporated during melting.

A modified process has lately been proposed, as follows:

80 lbs.	cocoanut oil.
80 "	tallow.
180 "	21° soda lye, mixed with
20 "	32° potash solution.
40 "	38° silicate of soda.

The fat is mixed with the lye at the ordinary temperature of the atmosphere (60°); then the slightly warmer (72°) silicate is added; the mass then separates. Crutching is continued till all is uniformly dissolved when two pints of strong alcohol are added, which causes the ingredients to join at once. The soap thickens and must be framed quickly.

UTILIZING SCRAPS OF COLD SOAPS.

The profitable utilization of scraps is one of the difficult problems of the manufacturers of cold soaps.

The most feasible plan is the remelting of the same, as described in Chapter XIV. dealing with this operation. For factories making no soap at all by boiling, this is the more to be recommended, as some remelting apparatus are excellently adapted also as mixing vessels for the manufacture of soap by the cold process. Where a practicable remelter is not among the machinery in the factory, the scraps are sometimes melted on lye of 24–30° B. and the excess of strength is then absorbed by crutching in an equivalent proportion of cocoanut oil. **Remelting.**

The scraps may also be remelted in a jacket kettle, by having an open steam pipe leading directly into the soap, keeping the kettle covered up while the open steam is turned on, to prevent the same from throwing out the contents. By the open steam and that in the jacket, assisted by occasional stirring, the scraps are slowly melted. There are then added some salt water and some pearl ash solution, both at about 22° B. (according to the moisture already present in the soap), and in quantity depending on the composition of the soap, especially as to its proportion of cocoanut oil. To 150 lbs. of a pure cocoanut oil soap as high as 50 lbs. of each of the solutions may be added.

Another use which may be made of the scraps is for milling, if the necessary machinery is on hand. They must be dried for this purpose, like other soap for milling, and may be profitably mixed with about 8% of starch, which will make them more agreeable in use than ordinary cold-mixed soap. **Milling.**

A use which is sometimes made of such scraps in some European countries is for so-called Mosaic-soap, which is made by making a batch of cold soap of a certain color, and when almost ready to frame, adding the scraps of another color, cut into small pieces and mixing them in well. White scraps are thus mixed with red and brown, and yellow soap, and *vice versa.* For this purpose scraps colored with aniline colors are not well adapted as the latter has a tendency to spread into the white soap. **Mosaic soap.**

Another method is a combination of some of the foregoing, as follows: 200 pounds of tallow are melted to 185° F. and 325 lbs. of scrap (free from silicate filling) are then melted in the hot fat. Soon after the mass reaches a temperature of 185° F. again, the scrap will be melted, and the whole is strained into the **Another method.**

jacket kettle or crutcher ; 110 lbs. of 34° B. lye are then crutched in. The soap will at first be inclined to form lumps, but thins out by continued crutching. At this stage, some hot water, in which the color has previously been dissolved, must be added before the soap thickens again. After the lye has all been added, about 45 lbs. potash solution of 25° B. are crutched in. When the soap forms a short, thick mass, it is framed. If the scraps were taken from unfilled soap, the potash solution may be added at once, on melting the scraps, instead of waiting until the lye has been mixed in. Scraps filled with silicate cannot be so treated, as the filling would be decomposed, and sand-like grains would make their appearance.

A simple, but not altogether satisfactory way, consists in simply adding the finely cut scraps to the next batch of similar soap just before framing.

The cold process may also be employed for making soft soap, by using soft stock and potash lye instead of soda lye. It is unnecessary to give a detailed description of the same, however, as there is little call for it, and the details will readily suggest themselves from the special chapters on Soft Soap and on the Cold Process.

PART III.

CHAPTER XIV.

Remelting Soap.

When soap that has been hardened by cooling is subjected again to a warm temperature, it will assume a thickly fluid consistency similar to that which it originally had when framed. Advantage is taken of this property for melting over the trimmings left from cutting up the frames of soap, or for working over any soap which may have become "cracky" in the frame, or which is unsalable for any other reason.

In England remelting is also largely employed for making toilet soaps from stock soaps which the soap manufacturer furnishes to the perfumers and others for remelting, coloring, perfuming, etc. This practice was the natural outgrowth of the excise regulations governing soap factories formerly in force in England; but in the United States remelting is practically confined to the utilization of scraps and faulty soaps, as stated above, or for making small batches of floating soap.

In factories where soaps are made by boiling, the scraps may be utilized in the manner described at the close of Chapter VII (Settled Soaps), but owing to the reasons there explained, remelting is greatly to be preferred. During remelting the soap assumes a condition in which the use of a small amount of extra filling is not only possible, but even advisable, inasmuch as this "closes up" the melted mass, giving it a more even and solid texture—besides increasing the weight of the soap.

For factories making soap only by the cold process, remelting is really the most feasible plan for utilizing the scraps.

The manner of remelting necessarily varies with the machinery employed for the purpose, and it may here be remarked that practical soap makers are by no means equally successful in the

use even of the same machines for this purpose. The different apparatus described in Chapter V, as used for remelting, give good results when correctly used. More than on the machinery, however, the results depend on the character of the soap to be remelted and on the judgment exercised in the operation, especially when the soap contains much filling. The principal point to remember in remelting is that soap is a *bad conductor of heat.* For this reason the operation must either be allowed plenty of time, or the remelted soap must constantly be moved away from the steam-heated parts of the apparatus, so as to make room for the unmelted scraps directly near the hot parts of the machinery. All attempts to hurry the process will be unsuccessful if the arrangements are not such that the scraps are directly in contact with the source of the heat.

Soap a bad conductor of heat.

Referring to the various illustrations in Chapter V, the process of remelting is conducted as follows:

The machine is filled with the scraps and the kettle covered up (or the curb described in Chapter V is used), in order to prevent the steam from escaping into the room, and to thoroughly moisten the soap; open steam is then admitted into the contents until the scraps are beginning to melt.

Scraps that have become well dried before remelting will melt less easily than soap still containing a considerable proportion of water; with the latter it may not be necessary to add any open steam at all. When toilet soaps are made by remelting stock soaps (cut into shavings for the purpose), it may also be best not to use open steam, as these soaps are generally intended to contain but little water, so that they may resemble milled soaps as much as possible. If a combined crutcher and remelter is used for making a toilet soap by remelting, without the use of water or open steam, the conveyor screw should run very slowly. Half a day or more is required in this case for remelting a frame of soap. For ordinary uses, with the aid of open steam, the operation proceeds much more rapidly, however.

When the soap is observed to begin melting, the open steam is shut off and the closed steam turned on, so as to heat the jacket, or coils, as the case may be. In the Whitacre remelter (Fig. 32) the soap, as it melts, is run off into the frames, and the contents of the latter occasionally stirred up, to insure uniformity of the mass, or the soap is run into the crutcher for mixing. If the machine used is a combined crutcher and remelter, more scraps are

added as the soap melts down, and the crutcher started for a few minutes until the melted soap and the fresh scraps are well mixed. Closed steam is then again turned on to melt the soap completely.

The open steam should be employed in such manner that it supplies only enough water for giving the remelted soap the original appearance and consistency of a newly made soap, and no more crutching should be done than is required to secure even melting of the scraps; too much crutching will make the soap frothy by incorporating with it air bubles, which will cause it to float. The same defect results also if the soap is crutched long when very thick, or if it is heated for too long a time, whereby it undergoes a peculiar alteration in its texture. Experience is here again the only reliable guide. **Open steam.** **Crutching.**

Care must, of course, be taken that no unmelted pieces remain, as they would cause a spotted appearance, especially if coloring matter or filling is to be added.

After simply remelting, the soap has not exactly the same appearance and consistency as the original soap from which it was made, and to improve it in this respect some filling is generally added while crutching, after enough soap for a frame has been melted. **Additional filling.**

The filling may be used similarly as in framing the original soap, and consists of various salts in saturated solutions—as, carbonate of soda, sulphate of soda, borax, salts of tartar, common salt, bicarbonate of soda, carbonate of potash, etc., according to circumstances. A favorite material, especially in good soaps, is pearl ash (carbonate of potash) dissolved in water, which causes the simultaneous formation of carbonate of soda and of potash soap in the mass, thereby very noticeably improving the texture of the product. (This change is similar to that mentioned under "Potash," in Chapter III, and further explained in note 11 of the Appendix.)

For a good toilet soap such an addition of filling is, of course, out of place, and, in fact, toilet soaps are best made by milling, which is the usual process in this country; while the cheaper grades of this kind are generally made by the cold or the half-boiling process.

The stock for remelted toilet soaps would have to be selected according to the product to be made. A settled soap made of tallow and a small proportion of rosin, a small proportion of cocoa-

nut oil soap — to increase the lathering properties—white curd soap, and, perhaps, also some soft potash soap, may be blended together by remelting, in proportions to suit. A closing mixture, consisting of a saturated solution of say 12 lbs. pearl ash is then crutched in for every 1,000 lbs. of soap, and the color and perfume added. The mass is then run into frames.

CHAPTER XV.

Milled Soaps.

General Remarks.

Of all soaps made those properly prepared by "milling" are the best in many respects. In point of intrinsic merit as a soap they are preferred because they contain the least possible amount of water, and are usually prepared from the best materials, and with the greatest care; besides every well-made soap is improved by repeatedly re-working it. Owing to the extra time, the special machinery, and the quality of the ingredients required to make the really good kinds of the milled soaps, they are naturally somewhat more expensive; but they are also more lasting in use, because their small proportion of moisture and their dense texture make them waste away less quickly, while in point of neutrality and delicacy of perfume they are unequalled by any other soap. In appearance also, which is a not unimportant item in a toilet soap, they are beyond comparison, for the process by which they are manufactured gives them a high finish and preserves them from shrinking, no matter how long they are kept.

Superiority of milled soap.

These remarks, of course, refer only to those soaps that have been made with that care and of such purity as are looked for by the buyer of milled soaps; they do not apply at all, or at least not in the same degree, to those milled soaps, for instance, that are sometimes made from a cold-mixed soap, either for the purpose of working up the scraps, or for the sake of merely giving a cold-made soap the appearance of a milled soap; nor do they apply to some boiled soaps whose ingredients or manufacture have been faulty.

The process of milling itself is merely a mechanical operation to which a well-boiled soap is subjected, but the improvement

effected by it is quite important. It consists in preparing the soap by drying until only enough moisture is left to enable it to form a compact cake, grinding it between rollers to make it perfectly homogeneous, and adding to it—while grinding—the perfumes and colors, whereby the admixture of these ingredients is made not only more intimate, but also at a considerable saving of perfume, of which more or less would be lost by evaporation if crutched into the hot soap. An additional advantage arises from the exposure of the shavings to the air for drying, during which any free caustic alkali that may be present is converted into the less corrosive carbonate by the absorption of carbonic acid from the atmosphere. Incidentally, however, milling also offers an opportunity for greatly adulterating soap; by the use of starch, talc, and other dry powders, a well-appearing piece of soap may be made even if the stock soap is not quite dry. In an emergency, when the pure soap is troublesome in milling, the addition of from 5 to 10% starch will frequently be very helpful; but for purposes of adulteration the addition is sometimes increased to as high as 30 or 40 per cent.

Early methods of milling.

The process of milling originated in France, where it was at first carried on in the following primitive manner:

The soap was made into shavings by drawing the bars across an ordinary carpenters' plane so placed—cutting edge upward—over a marble mortar, that the shavings fell into the latter. In the mortar they were pounded into a doughy mass, and the color and perfume rubbed in by means of a wooden pestle and several hours of hard work. Small quantities of the mass were then weighed out to form cakes of the desired size, moulded by hand into a form approaching that of the cake, and after drying for a day pressed by means of a hand press. The soap so made soon gained a wide reputation, in consequence of which special machinery for making it in large quantities has been perfected, and milled toilet soaps now have a world-wide reputation and are manufactured wherever soap making has become an important industry.

STOCK FOR MILLED SOAP.

Only fresh and pure fats and oils are suitable for this purpose, for the delicate perfumes and colors would lose the principal part of their value, if combined with a soap of the peculiar odor and appearance arising from low-grade fats. It is also necessary that

the fat be most thoroughly saponified, for any free fat remaining would soon cause rancidity in the soap and thereby spoil the perfume. No amount of care in milling can save the soap from deteriorating and the odor from becoming disagreeable, if the soap itself was not well-made in boiling. Trouble of various kinds arising during the process of milling also is in most cases due to faulty manipulation in finishing the boiling, for unless the soap has been very thoroughly settled, it will not adhere together after milling. A good soap for milling should not be too short and brittle, and while it is still fresh it should adhere together on kneading it between the fingers, like soft, tough clay.

Tallow, or bleached palm oil, and from 10 to 20% of cocoanut oil make the most desirable stock for a soap that is to be made into a milled toilet article. Olive oil and olive oil foots also form soap of desirable quality for milling and are used to quite an extent for this purpose. The fats are saponified by boiling repeatedly with lye and then settling carefully. The process for making a "White Settled Soap," as described on page 168, etc., is excellent for this purpose. The fats are saponified in the first change, so that the soap remains sharp after boiling for half an hour, without the addition of more lye; it is then grained, not too strongly, but so as to just separate the waste lye clear on the paddle. After a sufficient rest the lye is run off, the mass closed up again with weak lye of say 8°, and boiled for an hour or two. It is then again grained by strong lye of about 35°, this time so as to have a somewhat sharper grain. The lye is drawn off again after a rest of several hours, and saved for use in laundry soap, and by means of boiling water and open steam the soap is then thinned out for settling; it should not be thinned quite so far as to close up completely like a rosin soap, but only to form a very flat grain. After resting as long as possible, the clear soap is framed. Saponification.

In regard to properly settling soap that is to be milled afterward, there is much diversity of opinion arising from the fact that, when no starch, rosin soap, or other binding material is used, the soap will be cracky on coming from the plodder, unless the niger and foreign salts have been settled out very thoroughly. In order to remove these impurities as nearly absolutely as may be, different means are adopted by different soap makers, and this is one of those particulars in which the most expert have "agreed to disagree" most decidedly. Most manufacturers simply settle the soap as just described, making as large batches as possible at a Settling.

time, in order to give the soap the benefit of as long a rest as possible to drop the impurities, and using, if necessary, some special ingredients to secure greater cohesion between the particles of soap in case it is defective in this respect.

Others hold that the presence of some pearl ash or soda ash in finishing the soap contributes to a more thorough settling out of the impurities, and accordingly they adopt this method of settling soap intended to be milled.

Again, still another proceeding is used by some well-known manufacturers of first-class soap which consists in running the hot soap into wooden frames, and allowing it to drop the nigre there. When the soap has hardened and is cut up, it is found that the nigre has been forced upward toward the center of the frame, where it is plainly visible, and may be cut out. The cause of the rising of the nigre in this manner from the bottom of the frame is not as yet fully explained, but it may be compared to a similar action which sometimes occurs in the kettle after steam has been turned off and boiling ceased. This process makes it necessary to return on an average about one-third of the soap into the kettle, and is consequently somewhat unpleasant and laborious, but the pure soap obtained is in a first-class condition for milling.

Special stock. A palm oil soap made in a similar manner as described above, from bleached or unbleached palm oil, is a very useful one for milling purposes, as is also a cotton seed oil soap which may be used to advantage as an addition to other kinds, when the soap in the plodder does not work satisfactorily. The advantage of using some castor oil in soap for milling has already been mentioned in the description of that oil.

Where scraps of cold-made cocoanut oil soap are to be worked up by milling, it may sometimes be done to advantage by using a soap boiled from tallow alone.

THE MILLING PROCESS.

Chipping the soap. The soap, after it has been stripped and cut, is dried for about a day in bars, and then cut into thin shavings by a machine called the "chipper," such as illustrated on page 129. Only as much soap should be cut as can be used up in a day or two after drying, for it has been found that from shavings exposed to the air too long a time, the finished soap will have a less beautiful finish. The shavings are then spread out in layers to dry, and if possible

are placed on sieves for this purpose, so as to dry as evenly as possible. The process may be conducted in a drying room heated by steam, or simply by exposure to the air. In the latter case its duration is very indefinite, while in the former it may be finished in from 12 to 24 hours.

Drying. The proper degree of drying is somewhat difficult to judge, and it takes some experience to regulate it correctly. While in bars, a settled soap, made as described, will contain about 35% of water; for milling it has been found that about 18% of water is the best proportion, so that about one-half of the water present in the freshly cut shavings must be evaporated in drying, in order to obtain the best results. Insufficiently dried soap will be smeary and streaky, blisters readily and comes very easily and rapidly out of the plodder; in drying out afterwards some of the perfume will escape, along with the evaporating moisture; but if the drying be overdone the soap will be wanting in the necessary cohesion and will consequently be cracky as it comes from the plodder; the machine will work heavily, and only by heating the nozzle considerably can the soap be made to hold together at all. Unevenly dried shavings will require more milling in order to make the mass homogeneous; if this is neglected the cakes will be of uneven density, will therefore not dissolve evenly, and consequently show a ruffled surface and streaky appearance in use. The best and most reliable method of ascertaining the proper degree of drying consists in slightly overdrying the shavings at first, and then carefully adding the necessary amount of water as the soap may require. Some use shavings of fresh soap in place of water for this purpose, but water is preferable.

Perfuming and coloring. Before adding the color and perfume, the shavings are passed once through the mill, as the soap will pass better through the rollers—which must be set a little further apart this time—if there are no additions made at first which make the shavings slippery; besides the perfume and color are distributed more thoroughly in this manner.

The soap, as it comes in thin ribbons from the mill, is run into a box which is lined either with zinc or lead, and the previously calculated quantity of color and perfume is mixed in as well as possible.

Milling. The mass is now again ground in the mill, the rollers of which are set a little closer than they were the first time. This process of running the soap through the mill is repeated several times,

according to the number of rollers on the machine, say about four times through a five-roller machine, until the mass is entirely homogeneous and free from streaks. The last time it comes from the rollers as thin as paper.

The plodder.

From the mill the soap passes into the hopper of the plodder. This machine feeds it automatically into a compartment where it is subjected to an enormous pressure, forming it again into a compact mass. On the end of the machine opposite the hopper there is a nozzle into which a die of any desired shape is set, so that the soap is forced out through it in one continuous bar of any desired form, so long as the supply in the hopper is kept up.

Heating the nozzle.

The end of this nozzle is kept warm, either by a direct flame or by a steam pipe placed around it, as the heat so applied makes the soap come out smooth and glossy. A good, pure soap, made mostly of tallow, will have a better finish with more heat at this part of the machine than one that is made of more cocoanut oil, and, perhaps, even containing filling. If too warm it will cause a streaky and rough finish if the soap is too soft, or blistered if too tough. The first few feet of the bar issuing from the plodder must be returned to the hopper, as they are not sufficiently compressed and would therefore be apt to crack afterwards, as is also the case if the soap shavings had been too dry.

Heating of plodder.

From the continuous working of the machine under high pressure the interior parts of the plodder may become heated, causing the soap to be blistered and otherwise unsatisfactory; some plodders have therefore been provided with a cold water jacket. However, as this operates on the soap in the first place, instead of on the heated parts of the machinery, it is better to stop work till the machine cools off.

Remedying defects in the soap

Sometimes, for some reason or other, the soap comes from the plodder wanting in the proper degree of pliancy. At such times the very careful addition of a little glycerine to the soap, on its last passage through the mill, may remedy the defect. Some cotton seed oil soap, added to it, may also be of benefit; or if the trouble arises from overdrying of the shavings, some water or shavings of fresh soap may be incorporated by thorough milling. Others again resort to the use of a few pounds of mineral soap stock, or melted bees' wax, paraffine wax, or rosin soap. The addition of some (pure) gum tragacanth, which has previously been made into a mucilaginous mass with water, is to be highly recom-

mended in this connection, as it improves the lather and holds the soap together, preventing cracking.

A cutting machine with a single wire is placed so as to cut the continuous bar into convenient lengths, corresponding with the size of the cakes, and after a very short time for drying the soap is ready to be pressed.

Pressing. On pressing cakes of milled soap, its peculiar texture is made very prominent through the change in the shape of the bar, whereby the difference in the grain of the ends and the sides respectively—caused by the action of the machinery—is plainly shown by a mark. A machine has been patented for pressing cakes directly from the long bar, cutting off the soap required for a cake by the die, to obviate this mark.

New system machinery. A system of milling soap as it comes from the kettle, without intermediate framing, has been briefly described in Chapter V, but, as it is not as yet in practical use in this country, further details may be omitted. (See illustration opposite page 87.)

PERFUMING MILLED SOAP.

The subject of perfuming soaps in general will be treated hereafter in a special chapter (XVI), but a few remarks, which refer especially to the milled soaps in which the proper perfume is so important for their success, may find place here.

Difference in perfuming various soaps. The composition of the oils and tinctures, when incorporated into an odorless, well-made soap by milling, retains its original odor unimpaired. In this respect there is a great difference between milled and cold-made soaps, for, in the latter, the perfume undergoes a change, no doubt induced in the course of the chemical reaction of the lye on the fat. A formula which gives a satisfactory and even elegant perfume for one, may therefore be far from making a pleasant odor for soap of the other process.

Quantity of perfume used. It has further been demonstrated by practical experience that milled soap requires a larger quantity of perfume than does cold-made soap, in order to make the odor equally prominent; this is undoubtedly owing to its more intimate incorporation by milling, and is amply repaid by the increased durability of the odor.

Mixing of perfumes before adding. Instead of mixing the oils directly with the shavings, which causes a considerable loss by evaporation, the ingredients for the perfume may be mixed previously with a small amount of pure, odorless, white vaseline. Some manufacturers also use some orris

root in the dark-colored milled soaps, one pound of which (for every 100 lbs. of soap) is made with the perfume and vaseline into a dough-like mass and mixed with the shavings after they have passed through the mill once.

Lasting qualities of perfume.

Orris root and a carefully proportioned small quantity of liquid storax (either alone or melted together with the vaseline) make an excellent base for all perfumes in milled soap, making the odor more pronounced and more lasting. The same is true of the tinctures of benzoin, tolu, and civet. Tincture of musk also acts in the same manner, and where the price of the soap will permit it, it should always be used for bringing out the perfume, and for making it lasting. The tinctures named should be used in a somewhat more concentrated form than is usual when they are employed for handkerchief perfumes.

CHAPTER XVI.

Coloring and Perfuming.

At the present time, when so much weight is placed on the outward appearance of the soap, few kinds are on the market which are not more or less elegantly perfumed—especially those intended for toilet purposes, which are in many cases also colored. An agreeable perfume is frequently taken by the consumer as proof of a superior article, even though, as a matter of fact, it sometimes is rather the means of hiding a naturally disagreeable odor. Colors likewise can hardly be said to be of any actual, practical use, and in the case of a few may even be objectionable rather than otherwise. However, since the demand for a soap is generally increased by the judicious use of suitable color and perfume, their employment has become nearly universal.

COLORING.

The manner of applying the colors has already been described under the various processes of manufacture, so that only a few remarks about the colors themselves remain to be made.

For the sake of the good quality of the soap, if not for economy, it is always advisable to use only the smallest amount of coloring material that will give the required shade, and to select the shade in harmony with the perfume and name of the soap. Thus a "Rose" soap is naturally colored red, "Lily" soap is left white, "Vanilla" soap should be brownish-yellow, and so forth. The colors used may be divided into two classes: those which may be added in solution (in water, lye, hot soap or alcohol), and those which form an insoluble and impalpable powder. Some aniline colors that are insoluble in alcohol, as well as in water and lye, dissolve readily in oil sassafras, or in a mixture of oil sassafras,

Division of colors.

alcohol and glycerine. From another view they may be divided into perfectly harmless colors and those whose use, although ordinarily also harmless, may under certain circumstances—as when used by a person afflicted by some skin disease—give rise to unpleasant symptoms. The latter class is composed especially of those colors containing poisonous metals (mercury, lead, copper, arsenic), which are sometimes employed because they remain unaltered by time and exposure. Vermilion (red lead) and many kinds of aniline colors are of this class.

Natural color of soap.

Besides the colors added, we must mention the natural tints of soap made from certain stock, as reddish-brown from crude palm oil, yellow from rosin, greenish from hemp and olive oil, etc., and the brown color caused by the action of heat and lye on the sugar in transparent soap, and by impurities in crude potash.

The special colors used for soap are of an enormous variety, and yet a few colors, used either singly or in combination with each other, are sufficient to make up the principal shades desired.

White soaps are simply uncolored, but require great attention and the most scrupulous cleanliness in their manufacture, as their white color is extremely delicate. When they have naturally a somewhat yellowish hue, the addition of a very small trace of blue (ultramarine) will change the shade to a light greenish, which is at all events preferable to yellow and less noticeable. (Ultramarine is used in the same manner by sugar refiners and others, to improve the appearance of their product.)

Gray soap in all shades is made from white by the addition of varying quantities of black color, such as Ivory Black.

Brown, in a great variety of shades, is produced by Sugar Color, Brown Ochre, Cutch, Chocolate, Umber, Burnt Sienna, Turmeric, etc., and these may all be modified by the addition of yellow colors, producing an immense variety.

Yellow colors are also numerous, chief among which are Saffron, Cadmium Yellow, Annatto, Picric Acid, Naphthaline Yellow, Orange and Yellow Aniline; and for special shades also Turmeric and Bichromate of Potash. Sometimes crude palm oil is used in soap for the sake of its color and odor. Turmeric turns brown by the action of lye.

Red is produced by Indian Red, Venetian Red, Aniline Red, Vermilion, Alkanet, Carmine. Bole, Colcothar, etc.

Blue soap is now almost exclusively colored with Ultramarine in preference to Indigo, which was formerly much used. Ultramarine is also used in combination for shades requiring blue.

Green is produced by mixing blue and yellow colors, as Saffron or Chrome Yellow and Ultramarine; or Guinet's Green is used, or Chlorophyl, which, however, fades on exposure. For soft soap the use of hempseed oil is sufficient to make the product green.

Orange is made by mixing yellow and red, or Mineral Orange is used as a color.

Purple is a mixture of red and blue.

Other shades in great number are produced by the aniline colors, such as Fuchsin, Eosin, Bismarck Brown, etc., and by mixing several colors.

For instance, Buff is produced from mixing turmeric (1 part) and bichromate of potash (2 parts), dissolved in lye.

Special *Yellow* tints are made by combinations such as: Yellow Ochre 5 ounces, Burnt Sienna 10 drachms. Or: Yellow Ochre 1 ounce, Orange Mineral 1 ounce, Gamboge 5 drachms.

Still another shade is made of: Brown Ochre 1 ounce, Vermilion 2½ drachms, Ivory Black ½ drachm.

And thus the combination may be carried on without end.

PERFUMING.

The odorous substances are incorporated into the body of the soap either by milling or by crutching them in just previous to running the soap into the frame.

Many soaps, particularly the low-priced ones for the laundry, are perfumed simply by the incorporation of a single essential oil, so that in their case the perfuming is an extremely simple matter. Some importers of essential oils, as well as manufacturers of perfumery, also make a specialty of furnishing the soap manufacturers ready-made mixtures of essential oils and other aromatic substances, so that in the case of compounded perfumes, also, the soap maker need not *necessarily* trouble himself about the composition of perfumes.

Nevertheless, there are some general rules applying to perfuming soap which the manufacturer can not afford to be unacquainted with, the more so since every soap maker will find it to be of advantage to collect at an early opportunity a good stock of experience in this branch of his business, even if he should

find it more convenient for the time being to use only the ready-made mixtures. In making up a suitable combination of odorous substances the price is, of course, of the greatest importance to begin with. But a mixture of high-priced oils may be a very poor perfume, unless they are selected to harmonize with each other. To make up a suitable combination the odor which is to predominate is first selected and then compounded with such additions of other odors in suitable proportion as by experience is found to harmonize therewith. A small variation may mean a great deal practically in this respect. A very pleasant perfume, for instance, is made by

Compounding perfume.

Bergamot,	6	parts,
Rose geranium,	5	"
Patchouli	1½	"
Santal,	2	"
Valeria,	½	"

but, if the valeria be increased to 2 parts, the mixture will be simply nauceating.

Wasting oil by injudicious mixing.

Likewise, some oils are simply wasted by adding them to others which overpower them, or which form with them a mixture of an odor which is represented by some other, much cheaper oil, or quite insipid. Thus musk, which is very expensive, is practically killed by oil of fennel; otto of rose is overpowered by oil of peppermint, etc.

The substances employed for obtaining the perfumes suitable for soap are of several classes, namely:

1. *Vegetable substances*, comprising essential oils, balsams, rosins, roots, and bark. The essential oils are by far the most commonly employed ingredients for this purpose.

2. *Animal substances*, which comprise only a very small, but important number of raw materials for perfumery.

3. *Artificial products*, which are also not as yet very numerous, and mostly of quite recent origin. Some of these might also be classed with the vegetable substances mentioned above, from which they are extracted by more or less complicated chemical treatment, while others are entirely artificial products.

4. *Pomades*. The perfumed fat remaining when the principal part of their odor has been extracted from the flower pomades of the perfumer, is used to a limited extent for perfuming soap, by adding this fat to other stock, in the manufacture of soap by the cold process.

The following is a list of these various substances. (The plants from which the oils are derived are named, as in the case of some of the oils there is considerable confusion and misunderstanding):

ESSENTIAL OILS.

The essential oils are subject to evaporation and deleterious changes on exposure to the light, air, or heat, as well as to rust in cans. They ought therefore be kept in a cool, dark place, in glass vessels, and closely stoppered. Ready mixed perfumes may be kept in a somewhat warmer place, as the elevated temperature accelerates the action of the oils on each other, whereby the perfume "ripens."

ANISE OIL; made from the seeds of *Pimpinella Anisum;* should be colorless or faintly yellow. Below about 6c° F. it solidifies. Not to be confounded with oil of the Star Anise, made of the fruit of *Illicium Anisatum.* It must be used sparingly, as its penetrating odor easily overcomes that of other oils used.

BAY OIL; this name is given to two different oils: One, also called "Sweet Bay," from *Laurus Nobilis,* is used in soap; the other, also known as "West Indian Bay Oil," is from *Myrcia Acris,* and used in the manufacture of bay-rum.

BERGAMOT OIL, from the rind of the fruit of *Citrus Bergamia.* Pale yellow to green. Must be carefully kept from the air, as it is very prone to absorb oxygen and become turpentine-like in odor. It differs from other oils of the orange family in that it forms a clear solution with caustic potash lye.

BITTER ALMOND OIL, from *Amygdala Amara,* the bitter almond, but also largely made from peach kernels. Colorless. Keep in air-tight container, as on exposure to air the oil will change to a white colorless mass (Benzoic Acid). See also "Mirbane," under "Artificial Products."

CARAWAY SEED OIL, from *Carum Carvi;* light yellow, aromatic odor, acrid taste. Turns yellow brown by age.

CARAWAY CHAFF OIL has a less agreeable odor than that from the seed.

CASSIE OIL. Under this name an oil is brought into commerce, which is made from the black currant, *Ribes Niger,* but the real cassie perfume is from a flower, *Acacia Farnesiana,* the essential oil of which, however, is not an article of commerce. The oils are not to be confounded with Cassia Oil.

CASSIA OIL, from *Cinnamomum Cassia.* Yellow, gradually becomes dark reddish-brown and thickly fluid. It is similar to, but not as fine, as Cinnamon Oil. As it makes the soap yellowish it should not be used in white soaps.

CINNAMON OIL, from *Cinnamomum Zeylanicum.* Often adulterated with Oil of Cassia.

CITRON OIL, from *Citrus Medica.* Very similar to the Oil of Lemon, which is generally substituted for it.

CITRONELLA OIL, one of the grass oils, from the *Andropogen Nardus,* growing in Ceylon ; similar in odor to the Oil of Verbena, and the Indian Lemon Grass Oil, in whose place it is sometimes used. It varies from colorless to a greenish-yellow to brown color.

CLOVE OIL, from *Caryophyllus Aromaticus.* Colorless when fresh, but soon becomes yellow. Should not be used in Cold-made soap, except in small amounts.

DILL OIL, from *Semen Anethi.*

FENNEL OIL, from *Fœniculum Vulgare,* almost colorless and of a sweetish odor.

GERANIUM OIL, from *Pelargonium Roseum.* Also called "Oil of Rose Geranium," and closely resembling in odor the Oil of Rose, which is often adulterated with it. The names "Oil of Rose of Geranium," and "Turkish Oil of Geranium" are sometimes falsely applied to the Oil of Ginger Grass, and of Palmarosa.

LAVENDER OIL, from *Lavandula Vera.* Light yellow, very sensitive to light and air. The true lavender oil must not be mistaken for the Oil of Spike Lavender, *Lavandula spica,* which has a similar but much less agreeable odor. The best varieties are the English and the Mont Blanc oils of lavender.

LEMON OIL, from the fresh peel of the fruit of *Citrus Limonum.* Pale yellow, loses its odor rapidly on exposure to air. Often adulterated with turpentine, and on exposure to air becomes like the latter in odor. It is one of the most important oils for perfuming soap.

LEMON GRASS OIL, from *Andropogon Citratus,* resembles the oils of Lemon, Citronella, and of Verbena. It is sometimes also called "Oil of Melissa," a name which properly belongs, however, to the oil derived from *Melissa Officinalis,* which has a much finer odor.

LINALOE OIL. From the wood of the white cedar, *Licari Canali;* its odor is suggestive of the rose.

MACE OIL, from the flesh enveloping the nutmeg, *Myristica Fragrans.* Yellowish red. This oil must not be confounded with the fatty oil of mace.

MELISSA OIL, from *Melissa Officinalis,* is not used very much, being quite expensive. But sometimes the name is used to designate Oil of Lemon Grass, and the oil is therefore also called "citron-melissa."

NUTMEG OIL, from the fruit of the same plant which furnishes the oil of Mace, which it closely resembles.

ORIGANUM OIL is generally the misnomer for Oil of Thyme. Properly the name belongs to the Oil of Marjoram.

PEPPERMINT OIL, from *Mentha Piperita.* Colorless or pale green. This oil, from its cooling after effect, is much used—like the Oil of Wintergreen—for perfuming tooth soaps and similar preparations.

SPEARMINT OIL, from *Mentha Viridis.* Less fine than oil Peppermint, but has a characteristic odor, different from peppermint. Refreshing in dentifrices.

ORANGE OIL is of two kinds: From the *peel* of the bitter orange is expressed the oil of ORANGE BIGARADE; from that of the sweet orange the OIL OF PORTUGAL. If simply Oil of Orange is mentioned anywhere, the oil of bitter orange is generally meant. The oil made from the *flowers* of the true bitter orange is called NEROLI BIGARADE. If only the petals of the flowers are used it is called NEROLI PETALE. The flowers of the sweet orange furnish the oil NEROLI PORTUGAL. The oil distilled from the leaves of the orange tree is called oil PETIT GRAIN. The same remarks about keeping lemon oil, apply also to these oils.

PALMAROSA OIL, from *Andropogon Pachnodes,* is another name for the oil distilled in India from ginger grass, and also known as "Turkish Oil of Rose Geranium." Its odor somewhat resembles that of the oils of rose and of geranium.

ROSE OIL, ATTAR OF ROSE, OTTO OF ROSE, are the names of an oil derived from several species of roses. Varies from liquid to the consistency of butter; yellow or greenish in color. Almost solid at about 60° F. Said to be rarely unadulterated when it leaves the place of production (mostly with geranium and ginger grass oil and oil of rhodium.)

PATCHOULI OIL, from *Pogostemon Patchouly.* Dark-brown, ill-smelling till highly diluted. It serves as a basis for, and partly to fix, other perf·mes, and must be used very sparingly.

ROSEMARY OIL, from *Rosmarinus officinalis.* Colorless to pale green, with penetrating, camphor-like odor.

PIMENTO OIL, OIL OF ALLSPICE, from *Eugenia Pimenta.*

RUE OIL, from *Ruta Graveolens.*

SAGE OIL, from *Salvia officinalis;* not unlike peppermint, but less strong; imparts coolness to the mouth, and is therefore sometimes used for mouth washes.

SANTAL WOOD OIL, from *Santalum Album.* The wood from which this oil is made is sometimes erroneously called sandal wood, which is not fragrant and can only be used in perfumery for coloring purposes. Santal wood oil has a thick, syrup-like consistency. Copaiva Balsam is in some cases substituted for santal oil in soap perfumes, as the odor is very similar and the cost much less.

SASSAFRAS OIL. from *Sassafras officinalis;* yellow to red; much used in soap, but now quite extensively substituted for the purpose by "Safrol" and by "artificial oil of sassafras," made from Japan camphor.

STAR ANISE OIL, from *Illicium Anisatum,* resembles the oil of anise, which is sometimes adulterated with it.

THYME OIL, from *Thymus Serpyllum* and *Thymus Vulgaris.* Often misnamed "Oil of Origanum." This oil contains "thymol," which is valued as a preservative, and said to prevent soap from turning rancid. Two varieties, the red and the white, are known.

VERBENA OIL, from *Verbena Triphilla, Aloysia Citriodora,* has a pleasant, lemon-like odor. It is often adulterated or entirely substituted by Oil of Lemon Grass.

VETIVER OIL, from the roots of *Andropogon Muricatus,* has the property of making the odor of other oils more lasting. Reddish brown, thickly fluid, of intense, orris-like odor.

WINTERGREEN OIL, from *Gaultheria Procumbens.* Much used for soap. Frequently substituted by birch oil (from *Betula Lenta*), which is very similar. The Oil of Wintergreen is much used for similar purposes as the Oil of Peppermint.

YLANG-YLANG OIL, from *Unona Odoratissima.* One of the finest aromatic substances. *Canaga* oil is a cheaper variety of the same oil and more frequently used for soaps.

OTHER VEGETABLE AROMATICS.

BENZOIN, a gum rosin, with a vanilla-like odor, from the *Styrax Benzoin;* collected in a manner similar to that of pine rosin. That from Siam has the finest odor; Sumatra benzoin resembles styrax somewhat in odor.

PERU BALSAM, from *Toluifera Pereira;* used to fix other odors. With a vanilla or benzoin-like odor. As its odor is changed by the action of lye, it should not be used in a cold-made soap.

STORAX, from *Liquidambar Orientalis;* a balsam, used to fix other odors.

TOLU BALSAM, from *Toluifera Balsamum;* used to fix other odors.

ORRIS ROOT, from *Iridis Florentinæ.* It is much used for violet soap. (See also remarks on it in chapter on milled soap.)

BALSAM OF COPAIBA. A yellowish brown syrupy liquid, from several varieties of *Copaifera.* The best is that known as Brazil Balsam, which has an odor not unlike that of santal wood oil.

ANIMAL SUBSTANCES.

These are generally used more because they serve excellently for fixing the more volatile vegetable odors than for the sake of their own odor.

AMBERGRIS, a grayish-white secretion of the Cachelot whale. Soluble in alcohol, and has a pleasant musk-like odor if properly diluted.

MUSK has the most agreeable odor of the animal substances used in perfumery. It is derived from a deer, living on the plateaus of the Himalayas, which secretes it in a small sack on the hind part of the belly. It occurs in commerce as "musk in pods," and as "grain musk." It is used in extremely great dilution for the finest soaps, either for the sake of its own odor or because it serves so well to fix other odors. The grains should have a fatty, shining appearance and brownish black color; if they look dry and dull, a previous extraction of alcohol is to be suspected. It is frequently adulterated with dried blood, partly burnt meat, etc. By burning a small piece in an alcohol flame the odor of burning flesh reveals the latter sophistication. The best musk is that from Tonquin.

CIVET, obtained from an animal related to the cat, found in Africa. It is a soft, smeary, white (later brownish) mass; its odor is somewhat like that of musk and ambergris.

ARTIFICIAL PRODUCTS.

HELIOTROPIN (Piperonal) is a chemical product related to Coumarin and Vanillin, and is much used to imitate the odor of the heliotrope, which it resembles very closely. It is readily soluble in alcohol and in vaseline, and in essential oils. A slight addition of Coumarin to it improves its odor; the oil of petitgrain, lemon, and bergamot harmonize well with it.

TERPINEOL is a liquid principle existing in several essential oils, and extracted from these and brought into commerce as "Lilacine." It has the odor of the lilac. Being volatile only at a high temperature, it can be used when the soap is comparatively hot. It is not affected by lye or fatty acids, but its odor and color change unless it is kept well stoppered.

SAFROL is a product obtained by the fractional distillation of oil of Japanese Camphor, and is identical with the principal constituent of oil of Sassafras, for which it is now largely substituted in household and cold-made soaps. It is either mixed with the soap, or, in cold-made soap, with the fats before adding lye. It is used either alone or mixed with oil of Citronella, to which a little oil of Cedarwood may be added to make it more lasting. This composition is one of the cheapest perfumes for soap that can be had.

ARTIFICIAL OIL SASSAFRAS is a production closely related to Safrol.

MIRBANE, also called "Nitro-Benzole," "Oil of Mirbane," "Artificial oil of Bitter Almonds," and "Essence of Mirbane." It is made of benzole (a coal tar distillate), by treating it with fuming nitric acid and sulphuric acid. It resembles the oil of Bitter Almonds in odor, but is very poisonous and explosive, and should therefore not be used for flavoring purposes, and be handled more carefully than usual. The name "Artificial Oil of Bitter Almonds" is also given to another product, Benzaldehyde, which is also a substitute for the natural oil, and non-poisonous. Mirbane turns the soap yellow on exposure to light and sun, and such soaps therefore require to be well packed.

VANILLIN, the odorous constituent of the vanilla bean, is made artificially from the sap of the pines. One ounce of it is calculated to be equal to 40 ounces of the best beans.

EUGENOL occupies a similar position to oil of Clove as Safrol does to oil of Sassafras.

COUMARIN is the odorous principle of the tonka bean, just as vanillin is of the vanilla bean, and is also manufactured artificially. It is soluble in alcohol and in vaseline.

ARTIFICIAL MUSK, or MUSK BAUR, is a product which imitates the natural musk odor, and is employed to some extent for soaps. It must be used in judicious quantity, and has not the property of natural musk to fix other odors.

SELECTION AND PREPARATION OF THE PERFUMES.

The proper selection of the kind and proportions of aromatic materials to be used for perfuming soaps is a special art, and in this respect most soap manufacturers are forced to rely on tried formulas, the preparation of a harmonious compound, from the numerous ingredients, requiring experience and skill. We therefore append a number of such formulas, but will add some special remarks for the guidance in selecting a suitable one.

Selection of perfume.

In the first place, in selecting a formula, it should be examined, of course, as to its cost, to see if the price of the soap will bear it. Then the composition must be considered, whether it contains oils that can affect the color of the soap, as in the case of oil of cassia for white soap. Then the use of the soap is to be considered; a toilet soap must, of course, never be perfumed to remind the consumer of the smell of laundry soap; tooth soaps are preferably perfumed with oils that have a cooling after-effect on the mouth, notably peppermint, spearmint, sage, and sometimes wintergreen; shaving soaps must have very little perfume, etc.

For perfuming milled soaps the special chapter treating of these gives some specific instructions.

For cold-made soap many otherwise good formulas for perfumes are not adapted, as some oils undergo a change when they are in contact with the raw materials while saponification is being effected.

In regard to the purity of essential oils we give no instructions for testing for adulterations, as these tests require considerable

skill in manipulation and are frequently not even conclusive. The safest plan is to buy of the houses having the best reputation, and to examine the oils carefully for their odor, comparing a few drops—dropped on blotting paper—with a sample of an oil of known purity. A well-trained sense of smell is the only practical guide for the soap maker in this respect.

The formulas below are given in parts by weight, but in practice it will be found more convenient, as a rule, to measure the oils in a graduated glass, instead of weighing them. The weight of a majority of the different oils is sufficiently similar to permit of measuring in this manner without causing bad results.

Preparing the perfume. If possible the oils should be mixed a few weeks before they are required to give the perfume time to blend into a harmonious compound before using.

In toilet soaps it is always advisable to use some of the tinctures, etc., which have been described as serving to make the odor more lasting; as the loss of the latter during the time the soap is in the store would detract from its value, perhaps make it unsalable, and hurt the trade. These "fixing agents" are especially: The tinctures of Musk, Civet, Ambergris, Benzoin, Tolu, Balsam of Peru, and Storax; also Orris Root (finely powdered, or the tincture).

Additions of this kind should not be omitted for the further reason that they permit of some economy in essential oils, a smaller quantity of which will have a stronger and more lasting effect than where no such addition is made.

The tinctures may be bought ready for use, or can be made by dissolving or extracting the drugs mentioned with alcohol in the following manner:

TINCTURE OF MUSK.

Musk in grain	1 oz.
Civet	80 grains.
Carbonate of potash	¼ oz.

Triturate the ingredients until no more ammoniacal vapors are evolved. Then gradually add two quarts of boiling water, and lastly add 2 quarts of strong alcohol. Let stand at least a week before using.

Or,

Musk, in grain	1 oz.
Alcohol	2 quarts.
Granulated sugar	2 ozs.
Potash	1 oz

Triturate the musk and sugar, gradually adding the alcohol. Let stand as long as possible before using, occasionally stirring.

Or,

Musk, in grain...................... 1 oz.
Alcohol .... 10 ozs.

Triturate the musk with the alcohol, using a little ammonia water (about ½ oz.) with it, and shake occasionally for five or six days. After filtering, extract again with only 5 ozs. of alcohol; repeat a third time and use the weak tincture in place of alcohol the next time.

For a cheap product, American musk, from the American Muskrat, is sometimes used, by steeping it for a few days in warm water, and then adding an equal volume of alcohol. **American Musk.**

TINCTURE OF CIVET.

Civet............................. 2 ozs.
Orris root (ground)................. 3 ozs.
Alcohol........................... 5 quarts.

Triturate the civet and orris root, gradually adding the alcohol.

Or,

Civet .... 8 ozs.
Oil Lavender....................... 4 ozs.
Alcohol............................ 5 lbs.

Rub the civet and the oil together in a warm mortar, add the alcohol and shake well. Rest, filter and make a second extraction as described for tincture of musk.

TINCTURE OF AMBERGRIS.

Ambergris .... 2 ozs.
Alcohol........................... 3 quarts.

Treat the same as for civet. The ambergris is made into small pieces with a knife, or may be triturated with some sugar. Let stand for several weeks before using.

TINCTURE OF BENZOIN.

Benzoin............................. 1 lb.
Alcohol............................. 2 lbs.

TINCTURE OF BALSAM OF PERU.

Balsam of Peru	1 ℔.
Alcohol	2 ℔s.

This tincture has a dark brown color, and a pleasant odor. It should be used only in soaps whose color is not affected by it.

TINCTURE OF STORAX.

Storax is treated in the same manner as Benzoin and Balsam of Peru.

TINCTURE OF ORRIS ROOT.

Powdered Orris Root	1 ℔.
Alcohol	10 ℔s.

This tincture is of value for fixing other odors, but is sometimes also sold by itself as a cheap violet perfume. Ordinarily orris root is used in soaps in the form of an extremely fine powder.

TINCTURE OF TOLU.

Balsam of Tolu is treated with alcohol like Benzoin and Balsam of Peru.

TINCTURE OF VANILLA.

Vanilla	1 ℔.
Alcohol	10 ℔s.

When exhausted the vanilla is stood aside, exposed to the air, for a time, when the odor will be renewed and may be used by a second extraction.

PERFUMES FOR LAUNDRY SOAP.

The following are some formulas for the perfuming of laundry soaps. The quantities are calculated for a frame of about 1,200 ℔s. and may, of course, be changed to suit.

1.	Oil of Mirbane	1½ ℔s.
2.	Oil of Sassafras	1½ ℔s.
3.	Oil of Mirbane	1½ ℔s.
	Oil of Citronella	¼ ℔.
4.	Oil of Citronella	12 ozs.
	Oil of Mirbane	4 ozs.

5.	Oil of Mirbane	1½	lbs.
	Oil of Sassafras	½	lb.
6.	Artificial Oil Sassafras	1	lb.
	Oil of Citronella	1	lb,

(A little oil of Cedarwood may be added, if desired, and will make the odor more lasting.)

7.	Oil of Lavender	1	lb.
	Oil of Citronella	1	lb.
8.	Oil of Lavender	1	lb.
	Oil of Thyme (white)	¾	lb.
9.	Oil of Caraway	1	lb.
	Oil of Fennel	¼	lb.
	Oil of Cloves	¼	lb.

10.	Oil of French Pennyroyal*	2	lbs.	
	Oil of Thyme (white)	10	oz.	
	Oil of Lavender flowers	10	oz.	
	Oil of Caraway chaff	5	oz.	(For white soap.)
11.	Oil of French Pennyroyal*	1	lb.	
	Oil of Cassia	1	lb.	
	Oil of Cloves	½	lb.	
	Oil of Lavender (spike)	1	lb.	(For colored soap.)

* This oil (*Ol. Menthæ Pulegii*) must not be mistaken for the American Oil of Pennyroyal which is quite different.

PERFUMES FOR COLD-MADE SOAPS.

As already stated, many odors are spoiled by being introduced into a cold-made soap, but the number of perfume formulas that could be given for these soaps is almost unlimited. The following selection will probably be amply sufficient, however, for all ordinary requirements. The proportion of the compounded perfume to be used in the soap must be left to the discretion of the manufacturer. For *laundry* soaps by the cold process the foregoing "Perfumes for Laundry Soap" may also be used; the following formulas are more especially for toilet soaps.

Oil of Bitter Almond......	4	parts.	
Oil of Bergamot..........	1	part.	(Almond.)

Oil of Bitter Almond......	3	parts.	
Oil of Bergamot..........	1	part.	
Oil of Citronella..........	1	part.	(Almond.)

Artificial Oil of Bitter Almond..................	22	parts.	
Oil of Lavender..........	8	parts.	(Almond.)

Oil of Lavender..........	2	parts.	
Oil of Bergamot..........	2	parts.	
Oil of Cassia.............	1	part.	
Tincture of Benzoe.......	2	parts.	
Tincture of Balsam of Peru	1	part.	(Violet.)

Oil of Lavender...........	1	part.	
Oil of Citronella	1	part.	
Oil of Palmarosa	1	part.	(Rose.)

Orris Root, powdered...	20	parts.	
Oil of Bergamot........	15	parts.	
Oil of Geranium........	7½	parts.	
Oil of Linaloe..........	9	parts.	
Tincture of Musk.......	1	part.	(Lily of the Valley.)

Oil of Citronella	23	parts.	
Oil of Sassafras	8	parts.	
Oil of Caraway...........	7	parts.	(Honey.)

(To this may be added, if desired, Oil of Thyme, 12 parts.

Oil of Cassia.............	20	parts.	
Oil of Rosemary..........	10	parts.	
Oil of Mirbane	2	parts.	(Violet.)

(Use in Palm Oil Soap.)

Oil of Geranium..........	20	parts.	
Oil of Mirbane...........	3	parts.	
Oil of Bergamot..........	10	parts.	
Oil of Cassia.............	1	part.	(Violet.)

Oil of Lavender.......... 1 part.
Oil of Caraway........... 1 part.
Oil of Cassia............. 1 part.
Oil of Thyme .... 1 part. (Omnibus.)

Oil of Citronella.......... 3 parts.
Oil of Bergamot.......... 2 parts.
Oil of Melissa............ 1 part. (Honey.)

Oil of Bergamot........18 parts.
Oil of Sassafras......... 5 parts.
Oil of Cloves........... 5 parts.
Oil of Thyme........... 5 parts.
Oil of Neroli........... 2½ parts. (Bouquet.)

Oil of Rose .... 2 parts.
Oil of Geranium.......... 3 parts.
Oil of Cinnamon.......... 1 part.
Oil of Bergamot.......... 2 parts.
Oil of Cloves............very little. (Rose.)

Oil of Caraway...........12 parts.
Oil of Bergamot..........20 parts.
Oil of Lavender.......... 8 parts.
Oil of Thyme, white ...... 7 parts.
Oil of Cloves............. 1 part. (Shaving.)

Heliotropin...........20 parts. } Dissolve in Oil.
Coumarin............. 5 parts. }
Oil of Petitgrain.......25 parts.
Oil of Geranium.......50 parts.
Oil of Bitter Almond...10 parts. (Heliotrope.)

Oil of Geranium..........10 parts.
Oil of Bergamot..........10 parts.
Tincture of Orris Root.... 6 parts.
Tincture of Benzoin....... 6 parts. (Violet.)

Oil of Bergamot........ 8 parts.
Oil of Rose........... 1 part.
Oil of Cloves........... 1 part.
Tincture of Musk....... 1½ parts. (Musk.)

Oil of Bergamot........	5 parts.	
Oil of Cloves...........	1 part.	
Oil of Thyme....	3 parts.	
Oil of Peppermint......	2 parts.	(Windsor.)

Oil of Caraway.....	4 parts.	
Oil of Lavender...	1½ parts.	(Windsor.)

(To this may be added, if desired, Oil of Bergamot, 2 parts.)

Oil of Verbena....	12 parts.	
Oil of Bergamot........	12 parts.	
Oil of Citronella........	10 parts.	
Oil of Palmarosa.......	12 parts.	
Tincture of Musk.......	1 part.	(Honey.)

Oil of Thyme...........	3 parts.	
Oil of Fennel.....	2 parts.	
Oil of Caraway.....	2½ parts.	
Oil of Lavender...	2 parts.	(Cocoanut.)

Oil of Lavender..	6 parts.	
Oil of Caraway..........	4 parts.	
Oil of Star Anise.......	3 parts.	
Oil of Fennel....	3 parts.	(Cocoanut.)

An old-fashioned but very good formula is the following:

Powdered Orris Root....	5,000 parts.	Mixed with the melted fat.
Powdered Orange Peel ..	2,000 parts.	

Liquid Storax..........1,000 parts.—Dissolved in a little hot fat and strained into the bulk of the latter.

Oil Lavender (French).	200 parts.	Added to the soap toward the end of crutching, together with the musk.
Oil Bergamot.....	300 parts.	
Oil Geranium.....	100 parts.	
Balsam of Peru.......	50 parts.	

Musk............... 10 parts. — Rubbed together with some of the lye or a little glycerine. (Violet.)

PERFUMES FOR (BOILED) MILLED TOILET SOAPS.

The following formulas are from the great number used for incorporation into ready formed soap, whether by milling or re-melting. Some of them no doubt would also give satisfaction for cold-made soap.

The following is a very fine fancy odor:

Oil of Thyme (white)	6 parts.
Oil of Orange	6 parts.
Oil of Bergamot	18 parts.
Oil of Caraway	9 parts.
✓ Oil of Lavender	16 parts.
Oil of Clove	9 parts.
Oil of Cassia	6 parts.
Balsam of Peru	6 parts.

Oil of Cinnamon	20 parts.	
Oil of Geranium	15 parts.	
Oil of Valeria	$\frac{1}{4}$ part.	
Tincture of Benzoin	14 parts.	
Tincture of Musk	17 parts.	(Musk.)

Oil of Cassia	3 parts.	
Oil of Lavender	2 parts.	
Oil of Caraway	3 parts.	(Windsor.)

✓ Oil of Orange	250 parts.	
Oil of Neroli	200 parts.	
Oil of Rose	20 parts.	(Orange Flower.)

(To this may be added, if desired, Musk 1 part.)

Oil of Lavender, Montbl.	5 lbs.	
Oil of Geranium, rect. on roses	1 lb.	
Oil of Geranium, African	3 lbs.	
Oil of Geranium, Turkish	1 lb.	
Oil of Patchouli, Penang	$\frac{3}{4}$ lb.	
Oil of Verbena, French	$\frac{1}{4}$ lb.	
Oil of Vetivert, Spanish	$\frac{1}{2}$ lb.	
Oil of Cloves, Bourbon	1 lb.	
Oil of Bergamot	2 lbs.	
Tincture of Musk	1 lb.	
Tincture of Ambrette	1 lb.	(White Rose.)

Oil of Rose..............	8 parts.	
Oil of Rose Geranium.....	6 parts.	
Oil of Cinnamon..........	2 parts.	
Oil of Bergamot..........	4 parts.	
Tincture of Civet..........	2 parts.	(Rose.)

Oil of Bergamot..........	12 parts.	
Oil of Lavender..........	8 parts.	
Oil of Caraway...........	6 parts.	
Oil of Peppermint........	3 parts.	
Oil of Thyme............	2 parts.	(Elder Flower.)

Oil of Lavender.........	2 parts.	
Oil of Linaloe...........	¾ parts.	(Lily of the Valley.)

Oil of Lavender.........	6 parts.	
Oil of Peppermint.......	2 parts.	
Oil of Caraway..........	2 parts.	
Oil of Lemon...........	1 part.	
Oil of Thyme...........	½ part.	
Oil of Rosemary	½ part.	(Marsh Mallow.)

Oil of Bergamot.........	10 parts.	
Oil of Geranium.........	2 parts.	
Oil of Neroli	1 part.	
Oil of Lavender	1 part.	
Tincture of Civet	1 part.	
Tincture of Musk........	1 part.	
Orris Root (powdered) ...	40 parts.	(Violet.)

Heliotropin..............	10 parts.	
Vanillin..................	5 parts.	
Musk	1 part.	
Balsam Peru.............	65 parts.	
Oil Geranium, Afr........	30 parts.	(Heliotrope.)

Oil of Thyme.............	2 parts.	
Oil of Caraway............	2 parts.	
Oil of Cassia..............	1 part.	
Oil of Lavender,..........	1 part.	(Elder Flower.)

Oil Linaloe	1	lb.	
Balsam Peru	10	ozs.	
Bitter Almond	2½	ozs.	
Tincture Benzoe	15	ozs.	
Bergamot	4	oz.	(Heliotrope.)

Oil of Bergamot	4	parts.	
Oil of Neroli	2	parts.	
Oil of Santalwood	2	parts.	
Tincture of Vanilla	8	parts.	
Tincture of Civet	8	parts.	(Frangipanni.)

Oil of Bergamot	8	parts.	
Oil of Lavender	4	parts.	
Oil of Cloves	2	parts.	
Oil of Nutmeg	1	part.	
Tincture of Musk	4	parts.	(Millefleur.)

Oil of Linaloe	5	parts.	
Oil of Bitter Almond	½	part.	
Oil of Cloves	4	parts.	
Lilacine	24	parts.	(Shaving.)

Oil of Citronella	3	parts.	
Oil of Lavender	1	part.	(Honey.)

Oil of Caraway	3	parts.	
Oil of Lavender	2	parts.	
Oil of Rosemary	2	parts.	
Oil of Star Anise	½	part.	(Honeysuckle.)

Oil of Opoponax	50	parts.	
Oil of Citronella	250	parts.	
Oil of Cinnamon (Ceylon)	15	parts.	
Oil of Palmarosa	100	parts.	
Vanillin	5	parts.	
Coumarin	2	parts.	
Musk	1	part.*	(Opoponax.)

*Rubbed together with sugar, or an equivalent in tincture.

Oil of Wintergreen	1	part.	
Oil of Sassafras	1	part.	(Tooth Soap.)

Oil of Lavender, mont-blanc	4 parts.	
Oil of Caraway Seeds ...	2 parts.	
Oil of Thyme, red	1 part.	
Oil of Rhue	½ part.	(Brown Windsor.)

Oil of Thyme, white	2½ parts.	
Oil of Lavender, mont-blanc	5 parts.	
Oil of Caraway Seed	2½ parts.	
Oil of Marjoram	2 parts.	(Guimauve.)

Oil of Palmarosa	2 parts.	
Oil of Lavender Flowers, strong	2 parts.	
Oil of Lavender Spike, flowers	1 part.	
Oil of Rhue	½ part.	
Oil of Anise	½ part.	(A spicy odor for dark soap.)
Oil of Palommier	1 part.	

CHAPTER XVII.

Pressing the Soap.

When the soap, after solidifying in the frame, has been cut into slabs, bars, and cakes, it requires a period of drying before it is ready to be pressed, the time required for drying varying according to the nature of the soap, and the system of drying employed. (The effect of different methods of drying have been previously explained.) Frequently, in the pressure of business, soap is also pressed without drying properly.

Milled soap is ready for the press almost immediately after coming from the plodder. Other toilet soaps, cold-made as well as boiled, should dry at least until each cake is covered with a hardened layer or "skin" on the surface. If this skin is allowed to become too thick, through too long drying, it will cause the cake to crack in pressing ; but such soap can be made into exceedingly handsome cakes by a simple remedy, namely by cutting off the outer-most solid part of the skin. This process is sometimes adopted purposely with the object of giving the soap an improved appearance, as well-dried cakes of this kind, from which the hardest part of the skin has been removed by drawing each surface over the knife of an ordinary wood plane, will dry out less afterwards, will have a smoother surface, and will show the design of the dies in much sharper outline, than a soap that was simply pressed after drying somewhat. It may here be remarked that the smooth finish of a soap is improved also by using as thin wire for cutting as possible.

Where for any reason the process just described is not suitable —as when it is too expensive, or when the cakes were not cut in size to make allowance for the shaving taken off—the cakes may be softened by means of warming them, before pressing. The latter method is also frequently adopted when the shape of the

finished cake is such that the soap cannot easily be cut to correspond to its outlines, as for example when oval or round cakes are to be pressed from pieces cut square.

A special method of preparing the soap for pressing consists in exposing it for a very few moments to the direct action of a current of steam turned upon the cakes. The steam causes a change in the character of the soap on the surface and closes up all its pores; the soap thereby acquires a beautiful finish which remains after pressing, and will be better able to stand exposure to unfavorable weather.

The weather prevailing when soap is pressed is also of some moment, for most soaps sweat on days when the atmosphere is saturated with moisture and are then in poor condition for pressing. On such days the windows of the press-room must be closed to keep out the moisture. A clear, bright day is most favorable for this operation.

The cakes are previously cut to conform as nearly as possible to the size and shape of the die, in order not to strain the cohesion of the particles too much in pressing, and as said before, this may have to be supported by the warming of the cakes. Boiled-down soaps and some others, are so short in texture that they cannot be pressed at all, or at least only into very flat bars, for which reason they are in most cases merely stamped with the necessary letters, without pressing the cake itself.

Pressing twice. To prevent cracking, and to bring out the design of the dies well, it is sometimes necessary to press the soap twice, once in a plain die, which merely shapes the cake, and then in another die bearing the required design. In less extreme cases it is merely necessary to close the dies twice on each cake.

The dies themselves must be made in accordance with the grade of the soap to be pressed in them, as has been explained in Chapter V; and the design must be so cut that the soap may withdraw easily from the die, without sticking. Fine lines and sharp corners must be made as strong as possible, and must be adapted to the texture of the soap to be pressed.

Brass dies cause brown spots to appear on soap, especially if the latter contains free alkali, which attacks the metal of the dies. Laundry soaps, especially, are therefore better pressed in iron dies. The smoother the dies, the handsomer will be the soaps pressed in them, and some manufacturers use even nickel-plated dies for this reason.

A properly dried soap will hardly stick to the dies in pressing, if the latter are properly constructed. But frequently soap is pressed in a more or less "green" state, when it becomes necessary to use some lubricant or other to prevent sticking. Water or glycerine alone are not well adapted for the purpose, but a mixture of the two gives good results, as does also vaseline. Alcohol or salt water are used similarly, but the latter is not to be recommended, as it will crystallize on the surface of the soap. Vinegar also is used, but does not act equally well in all soaps. These liquids are applied by simply drawing a sponge, moistened with one or the other of them, across the die after pressing a few cakes, or whenever the soap shows an inclination to stick. Lubricating the dies.

It remains to say a few words about the care of the dies:

The life of a die depends entirely on the press, and on the care exercised in setting or fastening it to the press, and frequent examinations should be made to ascertain the condition of both press and die. Care of the dies.

As to the press, it is necessary that the slide or part to which the upper die is fastened should move easily, yet steadily, without shake in its bearings or guides, and this point should be examined daily, as pressers have been known to loosen the bolts in order to have easier work, and by this means ruin the die with a few impressions.

It is therefore very essential that a press should be so constructed that the guides can be accurately adjusted, both at top and at bottom, and securely fastened when this adjustment has been accomplished.

To fasten a die in the press, we should suggest to first place the upper die in its place in the slide and merely fasten the cap or set-screw, whichever may be used, with the fingers, to hold it in place; then place the box containing the lower die on the bedplate and carefully lower the slide, so that the upper die will enter the box without damaging the edges.

Holding the slide in this position by keeping the foot on the lever, loosen the cap or set-screw and place the box accurately, so as to place the clamps which fasten the box in the most convenient place, but so that the bolts will not touch the flanges or box to twist or strain the latter when fastened, and fasten the nuts or bolts with the fingers.

Now fasten the upper die securely. Before the nuts or bolts holding the box in place are fastened, endeavor to pull or push

them in either direction to ascertain their exact position. Should they shift, put them as near as possible in the middle of such motion and again turn down the nut or bolt and continue this until the play is overcome. Then fasten with a wrench, and carefully move the upper die up and down to see that it enters the box without striking it in the least.

You can then press a few bars of soap and again ascertain the accuracy of your work, and also see that the bolts or nuts holding the box are securely fastened.

The guide pins now very much used relieve the evil of careless setting very much, yet great savings in the cost of repairs can be secured by following the foregoing instructions.

PART IV.

CHAPTER XVIII.

Special Soaps.

FLOATING SOAP.

Floating soap, as made in this country since a comparatively recent time, is a soap into which air has been forced in the process of crutching, whereby its bulk is enlarged so as to cause it, when hardened, to float on the water. The object of this generally is perhaps not so much this property of floating as the fact that such a soap, when in use, presents a larger surface to the action of the water, and consequently dissolves and washes more rapidly. It is also obvious that any soap in a melted state can be made to float by the simple process of incorporating air as stated; but ordinarily only a white soap is so treated.

Floating soap may be made by the cold method, but half-boiling, as described on page 220, is preferable to it, if indeed the boiling process is not employed. In fact, a half-boiled soap is sometimes very apt to turn out floating against the desire of the soap maker. Still another method consists in remelting and crutching a (white) soap that has been previously dried somewhat by exposure to the air; this proceeding may be advantageous for working up scraps, or when the manufacture is not carried out on a sufficiently large scale to warrant making a separate boil.

Floating soap by remelting.

It is self-evident that floating soaps, being of themselves more than usually soluble, should be made largely from stock which naturally yields a less soluble soap, such as tallow, and that they should contain less water - rather than more—than ordinary soap. This latter point apparently is not as generally understood as it should be, to judge from the numerous formulas extant calling for the addition of water to the soap.

Stock for floating soap.

For the stock, only selected, fresh, white fats and oils are used. Probably no two manufacturers use exactly the same com

bination, and an equally good soap may be made from variable proportions of tallow, lard and cocoanut oil. Cotton seed oil should be used sparingly, if at all. A good soap results from tallow and 10 per cent of cocoanut oil, with or without the addition of some lard.

Boiling the soap. The stock must be thoroughly saponified with pure lye and finished in the same manner as described for "White Settled Soap," Chapter VII., page 168. The soap is allowed to settle and left in the kettle to cool to a temperature between, say, 170 and 180° F., at which it assumes the consistency most favorable for crutching. It may here be remarked that the exact temperature most suitable for the purpose depends somewhat on the composition of the stock, and may be ascertained more definitely than stated above in accordance; a pure tallow soap, for instance, would be apt to be too thick for crutching even before it could be made to froth sufficiently. If allowed to cool too far, part of the soap will stick to the sides of some crutchers, and must then be scraped out into the frames and there crutched again to prevent excessive warping through unevenness of the contents of the frames. If a crutcher is used that automatically scrapes the soap from the sides while working, and cuts up the lumps of soap forming, the necessity of recrutching in the frame on account of this difficulty will of course be avoided. On the other hand, if the soap is crutched while too hot, it will go down again in the frame before cooling, and the lower part will be too heavy to float.

Crutching.

When the soap has cooled and thickened sufficiently in the kettle, as stated, crutching is commenced. The exact proceeding now depends on the style of crutcher used; the machines having a vertical screw are filled with pure soap (no filling being used for White Floating soap), so that the cylinder which surrounds the screw still projects above the soap, as the latter must have room to expand. Besides, the air is incorporated more rapidly when the machine is filled in this manner, as the soap falling over the rim of the center-tube catches the air more readily than if the machine had been filled above the tube. When the Strunz crutcher is employed, a rapid method of operating consists in first filling the machine to only one-half of its capacity, crutching for about three minutes, and then filling the machine to within a few inches of the top, when only enough crutching will be required to mix both portions well. In this manner a frame of soap is ready in from 5 to 8 minutes, no matter how heavy it naturally is. As the frothy soap

in this case does not permit of judging exactly how much soap the crutcher contains, it is weighed into the machine.

The exact length of time required for crutching depends on the temperature, the consistency and the proportion of water in the soap, and on the style of machine used for the purpose; the operation is continued until the soap is slightly foamy. It is then run into iron frames, where it cools rapidly, and as it falls somewhat in the center on cooling—the more so the lighter it is—the edges may be pressed down when the soap begins to harden.

For perfuming Oil of Lavender is generally used, but, of course, any other white oil may be employed.

TRANSPARENT SOAP.

GENERAL REMARKS.

Original process.

Transparent soap consists of ordinary soap, to which certain additions have been made for the purpose of rendering it transparent. Originally it was made, by dissolving in about one-half its own weight of alcohol, a dry, neutral, boiled soap, and afterwards distilling off again—by means of the water bath—the greater part of the alcohol so employed. The soap obtained by this method is unequalled by the transparent soap made by any other process, as the soap—to begin with—was most thoroughly saponified, and the fact that it is dissolved in alcohol, permits of settling out at this stage a considerable amount of impurities which are present in soaps even that have been made of the very finest ingredients; the final product is consequently more nearly neutral, purer and clearer than a soap to which alcohol has simply been added in small proportions. However, this process is now but rarely used, as it is too expensive in comparison with later methods which have been more generally adopted.

Modern processes.

At present, the transparency of a soap is produced by means of the simple addition of alcohol. In most cases part of the alcohol required for the purpose is substituted by glycerine and sugar or sugar dissolved in water. The sugar solution causes even greater transparency than does alcohol, and in order to counteract its tendency to soften the soap, sal soda is added in those cases where the alcohol is substituted entirely by glycerine and sugar solution. Transparent soaps made in the latter way—*e. i.*, without alcohol altogether, and hardened by sal soda—are very liable to effloresce on keeping.

Glycerine, although not exactly absolutely necessary, makes the soap clearer and does not evaporate like water and alcohol; for this reason its use is to be recommended, inasmuch as it reduces the required amount of alcohol and sugar water. It is also less expensive than alcohol; but used in too large proportions it causes sweating of the soap.

The proportions used of alcohol, glycerine, and sugar solution, it will be noticed, are not definitely fixed, but vary in different formulas, as will be seen from the examples given hereafter. By using more or less castor oil in the stock, the required amount of alcohol is reduced, as this oil forms a naturally more transparent soap; too much of it, however, makes the product soft and sticky and also reduces its lathering properties.

Stock. The stock for transparent soaps may be the same as for the ordinary toilet soaps, and is generally tallow, with from 25 to 100% cocoanut oil, and more or less castor oil. Stearine is also used quite frequently. Whatever the stock, it must be very carefully purified by lye and alum, in the manner already described, as any impurities remaining are particularly noticeable in transparent soap. The glycerine used for light colored goods must be perfectly colorless.

Spots from lime. To prevent cloudiness and spots, care must be taken that all the materials used be free from lime. According to circumstances, lime may occur in the sugar, in the glycerine, and in the water, so that any one of these ingredients may be the cause of cloudiness, through the formation of lime soap. Sugar of a coarse grain is made from thinner solutions than small grained sugar, and therefore less liable to contain lime; that found on the market bearing the mark "Mould A" will very rarely give cause for complaint.

Glycerine likewise may contain lime and other salts, in which case the same trouble results. If the presence of lime is suspected in glycerine, it may be removed by warming the latter slightly, adding 1 lb. of 20° B. sal soda solution to 40 lbs. of glycerine, stirring well and resting.

The water used for dissolving the sugar should also be free from lime, and if condensed steam is not at hand for the purpose, the water should be first boiled and treated with soda as just described for glycerine.

Lye. If the lye contains too much of foreign salts, especially of sal soda, the soap will lose much in transparency on aging, and will effloresce; the lye is therefore best made of the highest grade of

caustic, and must of course be clarified by resting, just as has already been described for making lye to be used for the cold process.

The alcohol, especially for light colored soaps, should be free from fusel oil, which turns dark in contact with lye.

Apart from impure materials, failures in making transparent soap are generally the result of incomplete saponification, of an excess or a lack of strength, or of too small a proportion of liquid in the soap; a certain amount of the latter being required to produce transparency in the first place, even though it may dry out later. To make a good article, the saponification should be as thorough as possible and the soap be finished neutral before adding the sugar. For this reason half-boiled soaps to which the filling is not added until the soap is uniformly developed, will always be better than those made by simply crutching the materials together. For light colored soaps the sugar should not be exposed to a high temperature for the further reason that it would thereby become colored dark yellow to brown. **Discoloration by heat.**

For making a batch of transparent soap the stock is either saponified at a temperature of about 120° F.—the alcohol having been mixed with the lye before adding them to the stock, and the filling (sugar, etc.,) being added afterward—or the soap is made by the ordinary process of half-boiling and the alcohol, etc., added at the close of the saponification. The first-mentioned method is the quickest and most economical, but the latter forms a noticeably clearer and lighter-colored product, which is more completely saponified, and will therefore keep longer.

As already stated, the alcohol for transparent soap made by one or the other of these processes is commonly substituted in part by sugar dissolved in water; as the water evaporates and thereby causes the soap to shrink, the smallest necessary amount of it should be used only, and for strictly first-class goods it is omitted altogether—glycerine taking its place. The sugar is dissolved in a little water or in the glycerine by the help of open steam and added to the soap. When the soap is made by mixing the lye and alcohol before saponification, the filling is not added until a sample of the soap itself remains transparent after it is dropped on a piece of glass and has become cold and set. If the sample shows a milkiness, beginning *from the edge*, and on pressure of the finger splits up in numerous small, sharp-edged pieces and has more or less cloudy spots distributed over the whole surface,

it is a sign that the soap is too strong; a little stock must then be added, for which purpose castor oil is preferred, as it is least likely to injure the transparency in case any unsaponified particles should remain. Powdered W. G. Rosin has been similarly employed, but makes the soap softer.

But if the sample is milky, feels greasy and soft, and under pressure of the finger merely flattens out instead of breaking up into small pieces, it is a sign that the soap is too weak, and a little lye—diluted with boiling water to about 20° B.—will remedy the wrong.

If the sample on glass shows a fine network of clouds, and on cooling has the appearance just described of a soap that is too strong, and a heavy foam covers the soap in the kettle, more liquid —glycerine or water—is required.

Cutting and pressing. In cutting and pressing transparent soap it should be remembered that the longer it is left to dry before and after cutting up the frame, the better will it press. The cakes must be cut as nearly as possible to shape, as the soap will crack if it is attempted

Moulding. to force it in this respect. Oval cakes are for this reason made by running the soap warm into tin tubes, in which it sets and from which it is removed by pushing it out by any convenient contrivance. The tubes conform in shape to that which the cakes are intended to have, and a bar of soap is thus obtained from which the single cakes are cut off. For filling these tubes the soap, after settling, is dipped over into a jacketed kettle, from which it may be drawn off by means of a thin hose or pipe near the bottom. The lower end of the tubes is first plugged by means of hard soap.

For the purpose of settling out the impurities contained in every soap, it is convenient to use a vessel, which may be suspended in a water bath (as in water contained in a jacket kettle), so that the clear soap may be poured off without mixing with it the precipitated impurities.

Following are a number of representative formulas for various transparent soaps.

CRYSTAL TRANSPARENT SOAP.

140 lbs. Cochin cocoanut oil.
60 " Stearic acid.
80 " Glycerine.
99 " Lye, 39° B.
90 " Alcohol.

Or,

120 lbs. Cocoanut oil.
60 " Stearin.
60 " Glycerine.
60 " Alcohol.
90 " Lye, 38° B.

Mix the stock and the glycerine, heat to 120° F. and saponify by half-boiling, finishing the soap neutral. When the stock is well saponified, add the alcohol and raise the heat to 160° F. If the soap then is not neutral, add a few ounces of lye, or of stearic acid, as required, until the appearance indicates that it is correctly finished—according to the signs described in the foregoing General Remarks. The soap is allowed to rest and cool when it is dipped over into small frames or moulds. If framed too warm it might have a mottled appearance.

GLYCERINE TRANSPARENT SOAP.

80 lbs. cocoanut oil.
80 " tallow.
50 " glycerine.
85 " alcohol.
80 " lye 38° B.

The stock and the glycerine are mixed and brought to a temperaturė of 120° F., when the alcohol and lye, previously mixed, are run in. When the stock is well saponified, rest for two or three hours and add the color and perfume. The color may be burnt sugar or some aniline color that dissolves clear. If a light colored soap is wanted, half-boil the soap and add the alcohol afterwards.

TRANSPARENT SOAP WITH SUGAR.

100 lbs. cocoanut oil.
100 " tallow.
118 " lye 35½° B.
90 " alcohol.
25 " glycerine.
40 " sugar, dissolved in sufficient water to just dissolve it.

Or,

44 lbs. cocoanut oil.
44 " tallow.
26 " castor oil.
57 " soda lye 38° B.
40 " alcohol.
38 " glycerine.
20 " sugar, dissolved in 6 lbs. water.

Or,

37 lbs. cocoanut oil.
75 " tallow.
56 " 38° B. lye.
45 " alcohol.
56 " glycerine.
22 " sugar, dissolved in 7 lbs. water.

The stock is saponified and the soap finished as described under General Remarks. The sugar solution is added when the soap is otherwise finished. After settling and cooling somewhat, perfume and color are added and the soap framed.

TRANSPARENT SOAP WITH ROSIN AND SUGAR.

100 lbs. tallow.
50 " cocoanut oil.
50 " W. G. rosin.
105 " lye 38° B.
90 " alcohol.
60 " sugar, dissolved in 50 lbs. water.

Make the soap as previously directed, by half-boiling. Then add the sugar solution and settle for four to five hours. Color and perfume the clear soap in a separate vessel.

TRANSPARENT SOAP WITHOUT ALCOHOL.

40 lbs. cocoanut oil.
45 " tallow.
50 " castor oil.
50 " glycerine.
15 " sal soda.
81 " soda lye 30° B.
40 " sugar, dissolved in 45 lbs. water.

Or:

48	lbs.	tallow.
42	"	Cochin cocoanut oil.
50	"	castor oil.
85	"	lye 35° B.
40	"	sugar, dissolved in 40 lbs. water.
10	"	glycerine.
16–20	"	sal soda.

Make the soap by half-boiling and finish it neutral, as previously described. Then add the sugar solution and enough of the sal soda to harden. The solutions should be of about the same temperature as the soap. The sal soda is added in form of a fine powder.

TRANSPARENT SOAPS FILLED WITH SALTS.

For filling transparent soap, a solution is made of 6 parts of salt and 5 parts of potash in boiling water; 10 parts sugar are then added, and when all is dissolved enough cold water is used till the solution marks 22° B. while warm. The solution is settled and the clear part drawn off and crutched into the soap at 165° F.

Following is a suitable formula:

40	lbs.	cocoanut oil.
20	"	stearic acid.
10	"	castor oil.
36	"	lye 38° B.
14	"	glycerine.
20	"	alcohol.
40	"	solution as above.

SHAVING SOAP.

The manufacture of shaving soap has come to be a specialty with certain manufacturers, whose trade in the same is sufficiently large to warrant them in giving this soap that attention which is required for the production of a high-class article. Although almost any soap *may* be pressed into service for shaving, there are certain requirements which determine the fitness, and thereby the popularity of any given brand. These requirements may be summed up as follows: The soap must yield a strong, thick lather—which should remain as long as possible without drying; it must be mild in use, and must keep a long time without turning rancid.

To make a soap of the characteristics mentioned, great care and the best of materials are required. The stock most suitable is clean, hard, fresh tallow of the best quality and about 10 to 20% of cocoanut oil. The lye used is partly potash (say three parts soda lye and one part potash lye). Too large a proportion of cocoanut oil causes the froth to dry up rapidly and fails to render the hair soft enough for shaving; the potash lye causes the soap to yield a better lather than a pure soda soap, as it produces the froth more rapidly, while a soap made entirely with soda lye yields a poor lather—which is slimy rather than frothy. For the further improvement of the soap, an addition of gum tragacanth is often made, which serves to bind the soap together and also makes it very mild in use, and improves the lathering qualities. Bassorin, a constituent part of some gums and gum rosins, has been used in the same way. The gum tragacanth is incorporated with some of the hot fat, when the soap is made by the cold process. From 1 to 2 lbs. of the powdered gum to a frame will make a noticeable improvement. It may also be added to the soap by milling it in, as in the manufacture of toilet soaps.

COLD-MADE SHAVING SOAP.

400	lbs.	tallow.
50	"	cocoanut oil.
200	"	soda lye, 38° B.
25	"	potash lye, 38° B.

Or,

350	lbs.	tallow.
50	"	lard.
100	"	cocoanut oil.
220	"	soda lye, 37° B.
60	"	potash lye, 32° B.

Or,

300	lbs.	tallow.
40	"	cocoanut oil.
150	"	soda lye, 37° B.
24	"	potash lye, 33° B.

The stock is melted and strained and allowed to cool to 100° F., when the lye (previously mixed) is added—as more fully described in the chapter on the cold process. The soap is lightly perfumed with a composition somewhat as follows:

Oil lavender	15	parts.
" geranium	3	"
" caraway	10	"

Oil lavender	15	parts.
" thyme	10	"
" caraway	8	"
" bergamot	2	"

Oil lavender	8	parts.
" sassafras	6	"
" citronella	4	"

If gum tragacanth is to be added, it is previously mixed in some hot fat, taking care to get out all the lumps, and added to the stock in crutching. Of course, enough lye for the additional stock so used must be added.

HALF-BOILED SHAVING SOAP.

For making shaving soap by half-boiling the above formulas for the cold process may be adopted, using only a slightly higher proportion of lye, as the combination of the materials is more complete. The formula given for a white soap, in the chapter on the half-boiling process, page 218, is also suitable for a shaving soap. The method of operating has been described in the same place. We append one more formula:

200 lbs. tallow.
40 " cocoanut oil.
130 " soda lye 30° B.
25 " potash lye 30° B.

BOILED SHAVING SOAP.

As a soap made partly with potash cannot be grained with salt without losing most of the improvement in its character which is conferred on it by the use of this alkali, it is necessary to proceed somewhat differently than in the ordinary manner of boiling. The stock, selected as stated before, may be saponified with a mixture of 3 parts soda and 1 part potash lye of about 25° B. until it tastes slightly sharp, and boiled to evaporate any excess of water. Any small excess of strength present is then removed by working in carefully a small proportion of cocoanut oil. This soap will, of course, contain all the glycerine formed, just like that made by the cold process or by half-boiling. Again, the tallow

may be saponified alone with soda lye. grained on salt or strong lye, and settled well. After drawing off the waste lye, the potash lye and then the cocoanut oil are added, boiled till thoroughly combined, and either finished as before, or a settled soap is made.

ANTISEPTIC SHAVING SOAP.

For an antiseptic shaving soap it has been recommended to add 30 lbs. of salol in powder to every 1,000 pounds of soap while the latter is still hot. Salol, one of the most important of modern antiseptics, has been found effective in those species of skin diseases most apt to be transmitted in the act of shaving by barbers. Formerly shaving soap was often milled, but at the present time it is generally either cut square and pressed in round dies, or the round cakes, in which form it is sold, are punched out of the slabs.

TOOTH SOAP.

For the preservation of the teeth, it is admitted by dentists, nothing is better adapted than the free use of pure soap and a tooth brush. The innumerable preparations on the market, whether liquid, powdered, or in form of a cake, and especially the better ones, nearly always contain soap as the most valuable ingredient, and whatever else they contain, such as flavoring material, preservatives, etc., are only incidental additions of secondary importance, and sometimes even of only doubtful value.

The best means of caring for the teeth are a well-made, neutral and thoroughly saponified soap, followed by a mouth-wash made by a small quantity of permanganate of potash in water, flavored with peppermint, spearmint, or wintergreen oil. In addition to these, the occasional use of some finely powdered substance is indicated, and tooth soap therefore is, or should be, the best quality of soap into which has been incorporated more or less of some impalpable and insoluble powder. The latter should preferably consist of precipitated chalk, which is non-gritty and therefore least apt to damage the enamel of the teeth; next in usefulness is finely powdered pumice stone, which is used by dentists for polishing teeth, but should not be employed too freely. These two powders may also be employed together using only a very small proportion of pumice stone with a large amount of precipitated chalk. Other substances sometimes used for tooth soap are tacl, cuttle-fish bone, orris root, sugar (for improving the taste), glycer-

ine (for soft or liquid preparations), coloring (carmine, cochineal, aniline red), and flavoring oils. Some preparations contain salicylic acid, but this has been found to be destructive to the teeth; the same may be said of powdered charcoal, cream of tartar, powdered marble dust and other substances for which there should be no need in a tooth soap. Powdered myrrh, however, may be of use for hardening the gums. For an antiseptic tooth soap about 20 grains of thymol may be added to a pound of soap.

For flavoring the oils must be selected with reference to their taste; owing to their cooling and preservative effect the oils of peppermint, cloves, wintergreen, sassafras and cassia are most commonly used in tooth soaps.

The process of manufacture may be varied, but nearly all tooth soap is now made by milling. Many formulas have been published for making it by the cold process, but it is doubtful if any such crude products can really be sold; particularly are those formulas worthless which recommend to add the chalk to the stock before running in the lye, as chalk is but another name for carbonate of lime, whose presence in the unfinished soap causes the formation of lime soap. It is different when the chalk is added to a finished soap as it then produces no further chemical action. When other powders are substituted for the chalk the product by the cold process may be slightly better, but it will still be only a crude article, unfit for the purpose at best.

Half-boiled or remelted soap are an improvement over the cold process of course, but still not equal to milled soap.

We append two formulas.

HALF-BOILED TOOTH SOAP.

Tallow	35	lbs.
Soda lye 38°	16¼	"
Potash lye 20°	2½	"
Chalk	25	"

The stock is strained into the crutcher and saponified at a temperature of 165° F. with the lye which has previously been brought to a temperature of 100° F. After crutching for about 15 minutes the machine is covered up and saponification sets in during about one hour's rest. The soap is then crutched very slowly, as more fully described in the chapter on half-boiling, and when it has the appearance of a finished soap the coloring matter and the

precipitated chalk are crutched in ; lastly the perfume (say 6 parts oil peppermint and 1 of oil of clove) is worked in and the soap framed.

MILLED TOOTH SOAP.

Neutral soap	500	parts.
Orris root	200	"
Precipitated chalk	300	"

(Or chalk 250, and Pumice stone or Cuttlefish bone 50 parts.)

Glycerine, enough to make the powders into a stiff dough.

In order to keep the glycerine in, the cakes of soap are sometimes brushed over with tincture of benzoin and wrapped in tin foil when dry.

SCOURING SOAPS.

For cleaning and polishing articles by the simultaneous action of soap and strong friction, as for cleaning knives and forks, kettles, very dirty hands, etc., etc., a considerable number of different soaps are made which all agree in consisting of simple soap and as great an addition of some more or less gritty powder as the soap will bear. The great variety of these soaps is the result of the numerous different scouring materials added, selected according to the use for which the soap is principally intended, and the principal ones of which are :

Pumice Stone, Silex, Sand, Tripoli (an earth consisting mainly of silica), Bathbrick, Hornblende Dust, Emery, Kieselguhr (an infusorial earth), Crocus (a form of ferric oxide), Precipitated Chalk, and various clayey deposits found in numerous localities in more or less suitable variety. Asbestos has been recommended for use in soap for glassware, etc. To this list may further be added some special ingredients which enter some soaps for particular purposes, as alum, white lead, etc. As a typical example of the manufacture of these soaps we may describe that of Sand Soap.

SAND SOAP.

This soap may be made by the cold process, mixing the sand with the stock; but it is easier to make it by half-boiling, owing to the large quantity of sand added to it. Scraps of soap may also be used up for it by remelting. The stock used is preferably cocoanut oil, as it lathers more readily than others, with a large addition of an inert powder, and binds the materials most solidly together.

The quantity of sand added may be very high, but for a serviceable article it is best not to exceed, say, 50% to 75% of the weight of soap, which is crutched in as soon as the soap is otherwise ready for framing. In making the soap proper, weak lye of 32° to 35°B. should be used in order that the soap may not be too dry when cutting, and an addition of some mineral soap stock will be a further help to secure a smooth surface. The sand must be very dry when added, or the soap will turn out uneven and crumbly; and while running in the sand slowly the crutching machine should not run too fast, in order to prevent air from being incorporated. As it becoms very hard, it is, of course, necessary to cut it—with thin wire—as soon as cooled.

As in all other soaps, the addition of a part potash lye is an improvement, also, in this soap. Perfume may be added if desired.

When other substances than sand are used for these soaps the proceeding may be the same as above, but some manufacturers prefer to let the powder remain in the stock over night, and then add the lye next day to this mixture. If it is desired to obtain only the very finest part of any powder, such as of emery for polishing metal, etc., this may be done by stirring it up with water, and drawing the latter off at once when the heavier particles have settled, and repeating this once or twice. The powder suspended in the water drawn off is allowed to settle, drained and dried.

METAL POLISHING SOAP.

There are a number of soap preparations in use for polishing metals, some of which answer the purpose admirably. A formula for a good article of this kind is as follows:

Soap	480 lbs.
Precipitated chalk	60 "
White lead	30 "
Jeweler's rouge, or cream of tartar	30 "
Magnesia	30 "

The chalk, magnesia, white lead and cream of tartar must be in the finest powder and intimately mixed with each other, and are added to the soap and well crutched in, in the ordinary manner.

HARNESS SOAP.

For cleaning, oiling and blackening harness, the necessary ingredients required for the purpose are all combined into one mass, either in the form of hard bar soap, or as a semi-soft mass sold in boxes or jars.

A simple hard soap of this kind is made by adding to an unfilled rosin soap sufficient bone black and cod liver, or neatsfoot oil, to make a soap of the desired character. The oil has a preserving influence on the leather, and also maintains the black color better than an ordinary soap. Instead of bone black, which contains phosphate of lime and therefore is apt to cause a grayish color instead of black, there may be used lamp black, Frankfort black, or Berlin blue. For the purpose of making the color adhere to the leather, glycerine, molasses, or a mixture of the two is sometimes added.

The following formula furnishes an excellent product: A good settled soap (made of tallow, 10% cocoanut oil and not over 10% rosin) is mixed with 5% of tar, 10% of neatsfoot oil, and 6 lbs. of lamp black to 1,000 lbs. of soap. Naturally this soap will take a considerable time for drying.

For a soft soap of this kind, some hard soap is mixed with a small proportion of potash soap, say 80 of the former and 20 of the latter, and enough water is added to produce the required consistency. Some unsaponified oil and a little carbonate of ammonia are also added.

CARBOLIC SOAP.

For use in urinals and other purposes, a soap containing carbolic acid is frequently employed. (See also under "Medicinal Soap.") The process for making it is subject to the usual variations, but the principle underlying it is simply to make a hard tallow soap (which will dissolve slowly and thus waste less rapidly than others) and adding to it 10 to 15% of carbolic acid. Other disinfectants, especially chloride of zinc, are used in the same manner to neutralize the bad odor of closets, etc. It should be observed that in order to retain its effectiveness, carbolic acid should be added only to soaps containing no free alkali, and although cold-made soap is usually employed for the ordinary grades for coarse use, it would be more to the point to use more thoroughly saponified soap.

SALT-WATER SOAP.

For use with salt water, as on board of ocean vessels, soap is made entirely of cocoanut oil, as that made from other stock is insoluble in salt water. Such a soap may be made simply by saponifying cocoanut oil in the ordinary way by the cold process, or it may be made from 150 lbs. cocoanut oil, saponified with about 150 lbs. of 21° lye, and highly filled (after the manner of "Blue Mottled" soaps).

TAR SOAP.

This was one of the first, if not indeed the first of all medicated soaps made, it having been observed at an early time that tar has an excellent effect in chronic skin diseases. But its popularity is perhaps principally due to the fact that the soap has strong detergent properties, being excellently adapted for use of workmen whose work is such as to make the cleaning of their hands more difficult than usual.

A formula for this soap has already been given in the chapter on "half-boiling."

By the cold process this soap may be made—but less satisfactorily than by half-boiling—by saponifying 50 lbs. tallow and 50 lbs. cocoanut oil with 55 lbs. of 36° lye, and, when the materials have joined, adding quickly 8 lbs. or more of tar. The soap must be framed rapidly, as it thickens very soon. The tar, if only little is used, may also be dissolved in the warm stock before running in the lye.

Formerly coal tar was not infrequently used for soap, but at the present time pine tar, birch tar and juniper tar are in general use, since coal tar dirties the soap dish and towels, has a disagreeable odor and has not the healing influence possessed by wood tar.

Tar oil has been employed instead of tar with good success when the object of the soap is great cleaning power rather than healing properties. The proportion of tar used varies from 5 and 10 to 20, and even as high as 40, lbs. in 100 lbs. of soap. Freshly cut tar soap looks brown, if a comparatively small proportion of it is used; but on aging it turns black, for which reason it is not advisable to add coloring matter too readily, even if a very dark color should be desired.

GALL SOAP.

Oxgall contains a natural soap which has secured it a reputation as an ingredient for soap intended for removing dirt from col-

ored fabrics. It is even used pure in dyeing and cleaning establishments; but for occasional use in households, for removing spots, it is prepared in combination with soap, as it is impossible to preserve it otherwise. For a soap that is desired to keep well, it is best to prepare the gall by boiling it, and, when cooled to 190° F., stirring in 1 ℔. of acetic ether for every 20 ℔s. of gall. After resting some time the clarified gall may be drawn off from the sediment. According to the manner in which it is used, it may be added to the soap in the state just explained, or may previously be boiled down to half its original weight.

There are a great many different formulas for making this soap, but it would seem that a soap made and sold expressly for the treatment of delicate fabrics and colors ought to be the very best kind of soap, and entirely neutral, so that the only formula to use should be based on a well-boiled and finished soap. Such a formula would be, for instance:

Soap............100 ℔s.
Prepared gall..... 8 " (More or less, as desired.)

To this may be added some turpentine, borax, quillaya extract, ammonia, benzine, etc., as may seem to suit the trade best. The last two ingredients mentioned, however, will gradually be lost by evaporation. This soap is generally colored green.

MEDICINAL SOAP.

A healthy skin depends principally upon a healthy condition of the blood and the capillary blood vessels, and on a proper nerve tone, coupled with frequent ablutions to maintain the skin in a state of activity regarding all its functions. Washing, besides simply removing dead epithelial scales, impurities thrown out of the system, and dirt deposited on the skin from the atmosphere or articles touched, also stimulates the skin to proper action through the friction incidental to washing and drying. Soap is therefore one of the requisites for preserving a good complexion, keeping the skin clean and supplied with only the necessary oil by removing the excess accumulated, and maintaining due activity of the circulation. Under ordinary circumstances a good toilet soap answers this purpose better than any known substance if used judiciously, for too frequent ablutions or the application of unnecessarily large amounts of soap are not conducive to a healthy skin either. The skin of some people seems to be proof against a slight excess of

alkali in a soap, but a delicate skin is very sensitive to it, as carbonated as well as caustic alkali dissolve and remove the fat contained in the epithelium and leave the latter dry and prone to crack ; in extreme cases an inflamed condition of the skin may even result.

When the skin is affected by disease, cleanliness is again one of the essentials for a recovery, for it is readily understood that just after the disordered surface has been cleansed from all foreign matter it is in the most favorable condition to be acted upon by the topical remedies applied. Soaps in which the medicaments adapted to the particular disease in question are incorporated have long ago been found to be a not inconsiderable aid in treating the latter, for they furnish a, and often the, most convenient mode of application. The mistake should not be made, however, to expect impossibilities of them, and in the majority of cases they should be looked upon as valuable aids rather than as positive cures, for in diseases affecting the blood, the blood vessels, or the nervous system, and outwardly showing their effects on the skin, any topical remedy is obviously ineffective, except insomuch as it may tend to temporarily check these visible symptoms. A medicinal soap, properly applied, may be an invaluable aid in combatting a skin eruption arising from a disordered digestive apparatus for instance, but it is not difficult to understand that it can no more effect a cure, when used as the only remedy, than it can cure the disordered stomach.

Similarly it is not as generally understood as it should be, that a remedy that is capable of doing good, be it a medicinal soap or any other medicament, is also very likely to be capable of doing harm if improperly used, and this is indeed true of most medicinal soaps. For this reason the soapmaker should consider himself in line with the druggist rather than with the physician ; in other words he should not prepare the true medicinal soaps for indiscriminate sale, but rather direct his energy to the preparation of soaps to be sold on the recommendation of physicians. It is an undeniable fact that physicians have been for a long time prevented from employing medicinal soaps as much as they otherwise would, for the sole reason that, with a few notable exceptions, this class of goods has not been prepared with a due appreciation of what is actually required. This chapter is accordingly not intended to contain directions for making a line of soaps to serve as cure-alls, but rather as an explanation of the character of the soaps used by physicians in the treatment of skin diseases.

To begin then, the soaps used as vehicles for the numerous medicaments employed are the hard soda soap, the soft potash soap, and liquid soap consisting of potash soap dissolved in sufficient glycerine to keep it in the liquid state. The last two forms are coming into greater use than they were heretofore, for the reason that hard soap has some unavoidable disadvantages, as follows: It is very mild in its action (and for that very reason sometimes preferred); it is difficult to preserve without losing most or all of certain volatile or easily decomposed medicaments contained therein, such as carbolic acid and sublimate; its character is frequently changed by becoming alternately wet and dry. To obviate this it has recently been proposed to add the drugs to powdered soap which can be rapidly made into a soft soap by simply adding water. Each of the three classes of soap mentioned, hard, soft and liquid, is again divided into neutral, alkaline and superfatted soap, so that there are nine different bases to serve as vehicles for the remedy proper, according as circumstances require.

The alkaline soaps are the most strongly effective, while a milder action is obtained from the neutral and the superfatted varieties. A further graduation is obtained by regulating the quantity of soap applied, by the degree of dilution with water, the degree of friction applied, and by the length of time the soap is left in contact with the diseased skin. Of course it is also necessary to have due regard for the properties of the drug to be incorporated, as alkaline soap must not be used in connection with carbolic acid, for instance, and sublimate soap can be used only with neutral soap.

The manufacture of a neutral hard soap has been described in detail in the preceding pages.

A neutral potash soap must be made in an indirect manner, as a complete saponification with potash lye can be effected only in the presence of an excess of strength. The first step in its manufacture is to make a hard soda soap from the choicest fat or oil (olive oil) and soda. The fatty acids are next separated from the same by the addition of dilute sulphuric acid, and must then be washed out with distilled water until the latter runs off perfectly free from any trace of the sulphuric acid. The pure fatty acids are then saponified with pure caustic potash, taking care to finish the soap perfectly neutral. The product is then boiled down to the proper consistency.

The neutral liquid soap is made in the same manner, but diluted to the desired consistency with pure glycerine. Its color approaches that of honey, it is transparent and dissolves clear in water and in alcohol and is of course perfectly neutral.

The alkaline liquid soap is made from the foregoing by the addition of about 4% of carbonate of potash, and is an excellent detergent for the skin and for medical instruments. It is well adapted for the bath, washing the scalp and wherever scales and crusts are to be removed.

The superfatted liquid soap was formerly made by the addition of 3 to 4% of olive oil to the neutral soap; but as this free fat becomes rancid in time, it is now frequently supplanted by the same proportion of lanolin, which keeps indefinitely and is more readily absorbed by the skin.

The superfatted and the alkaline hard and soft soaps are made in like manner from the neutral soaps of their respective type.

The principal medicinal soaps, which have proved most serviceable in the hands of competent physicians, are the following:

Soft Soaps:

Tar Soap, containing 1 to 8 drachms of tar to the ounce.

Naphthol Soap, containing ½ to 3 drachms (or more) of naphthol to the ounce.

Carbolic Soap, containing 10 to 90 grains of carbolic acid to the ounce.

Salicylic Soap, containing 10 to 90 grains of salicylic acid to the ounce.

Sulphur Soap, containing any desired proportion of sulphur.

Balsam of Peru Soap, containing ½ drachm or more to the ounce.

Hard Soaps:

Alum Soap, containing 10% of alum.

Arnica Soap, containing 10% of extract of arnica.

Balsam Soap, containing 5% of balsam of Peru.

Boro-Glycerine Soap,* containing 10% of a 50% solution of boro-glyceride.

Camphor Soap, containing 10% of camphor.

*This soap is preferred to one simply containing boric acid or borax.

Carbolic Soap,† containing 5% of carbolic acid.
Chamomile Soap, containing 10% of extract of chamomile.
Ergot Soap, containing 10% extract of ergot.
Eucalyptol Soap, containing 5% of oil of eucalyptus.
Iodine Soap, containing 3% of resublimed iodine.
Naphthol Soap, containing 5% of naphthol.
Naphthol-Sulphur Soap, containing 3% of naphthol and 10% of sulphur.
Salicylic Acid Soap, containing 4% of salicylic acid.
Sublimate Soap, containing 1% of corrosive sublimate.
Sulphur Soap, containing 10% of sulphur.
Tar Soap,‡ containing 10% of tar.
Tannin Soap, containing 3% of tannic acid.
Tannin-Balsam Soap, containing 2% of tannic acid and 5% of balsam of Peru.
Thymol Soap, containing 3% of crystallized thymol.
Witch Hazel Soap, containing 10% of extract of hamamelis.

Superfatted Soaps:

Aristol Soap, containing 2% of aristol.
Benzoic Soap, containing 5% of benzoin.
Creolin Soap, containing 5% of creolin.
Creosote Soap, containing 2% of creosote.
Iodoform Soap, containing 5% of iodoform.
Iodol Soap, containing 5% of iodol.
Menthol Soap, containing 5% of menthol.
Menthol-Eucalyptol Soap, containing 5% of menthol and 3% oil of eucalyptus.
Pine Needle Oil Soap, containing 10% of pine needle oil.
Quinine Soap, containing 5% of quinine.
Resorcin Soap, containing 5% of resorcin.
Resorcin-Salicylic Soap, containing 5% of resorcin and 3% salicylic acid.
Resorcin-Salicylic-Sulphur Soap, containing 5% of resorcin and 3% each of sulphur and salicylic acid.
Salol Soap, containing 5% of salol.

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†The addition of glycerine lessens the smell of the carbolic acid. Naphthol or salicylic acid soap is often preferred to it on account of the odor.

‡See also formula, etc., on page 221.

Salicylic-Creosote Soap, containing 5% of salicylic acid and 2% creosote.

Sulphur Soap, containing 10% of sulphur.

Sulphur-Salicylic-Tar Soap, containing 5% each of sulphur, salicylic acid and tar.

Tar Soap, containing 5% of tar.

Thiol Soap, containing 5% of thiol.

WASHING POWDER.

Washing powders, usually sold to the consumers as soap powders, may be described in a general way as powdered mixtures of soap, with about its own weight—more or less—of carbonate of soda. Some special brands are also made which in addition contain other detergent agents, such as carbonate of ammonia, sal ammonia, or borax, while still others are found, to which filling in the form of talc, silex, etc., has been added. The soap itself may have been made by any of the processes known—cold, half-boiled or boiled, settled or boiled down—and the stock used may have been any fat, or mixture of fats, according to the grade of washing-powder to be made. It is thus seen that beyond being either principally or entirely a mixture of soap and soda, these powders have little in common with each other, and the process of their manufacture—and even the machinery used in each case—are equally at variance in the several factories, being decided upon independently and improved upon by the soap maker, in accordance with his own peculiar circumstances and experience.

It would, therefore, be useless to publish formulas for any one kind of this article, as the stock available, the selling price, the profit intended to be made and the manufacturing facilities are so different that no single formula might suit more than one reader—if any. We will instead describe its manufacture in a manner that will enable the reader to work out his own formula.

The average soap powder of the better grade, as stated above, consists of a soap and about a like amount of carbonate of soda, the latter being added either as sal soda or as a mixture of sal soda and soda ash. So far as the soap itself is concerned, the best is again one made by boiling and graining on salt, for, besides being more perfectly saponified, such a soap has the additional advantage of not containing the glycerine resulting from the saponification, and therefore remaining drier when in the form of powder.

Furthermore, it is lighter in color and purer, owing to the coloring matters and other impurities removed with the waste lye. Rosin is scarcely admissible, or at least not in any considerable proportion, as it would make the product sticky and difficult to reduce to the form of a powder. The stock used, say grease for instance, is saponified in the usual manner with soda lye, and, when it has a slight excess of strength, is grained on salt. The soap is allowed to rest, so as to drop the waste lye thoroughly and to cool off somewhat, and is then ready to be mixed with the soda, etc., unless it is intended to settle it first—as may be done to advantage in the manner described under "Settled Soap." On the other hand, the soap may also be boiled down, so that it will contain comparatively little water, in which case the carbonate of soda to be added may consist of more sal soda and less dry alkali.

Making the soap.

The mixing may be carried out in a crutcher, in flat boxes on the floor, or in a jacketed kettle (after drawing off the waste lye). If it is done in the kettle it should be one so shaped that the contents can be thoroughly worked by two men provided with hand crutches and stationed on opposite sides of the kettle. If wooden boxes are used, they should be placed on the floor, of suitable size for mixing, and not more than say 1½ feet deep, to permit thorough crutching; into these boxes alternate layers of soap and filling are placed and worked through by means of rakes. The easiest manner of working is undoubtedly by the crutching machine.

The ingredients to be added, if consisting of several kinds, are best previously mixed with each other, so as to insure uniformity of the mass. Some manufacturers use 50 lbs of talc, or—which is better—silicate of soda, and 300 lbs. of sal soda to every 300 lbs. of soap in the crutcher, and these are thoroughly worked through, taking care to avoid lumps as much as possible, whereupon the mass is spread on the floor of the drying room and turned over daily by means of rakes, until dry. This process requires nearly a week, and has been superseded in most places by substituting about 100 lbs. of soda ash for the same amount of sal soda in the above mixture, so that the formula would be in this case:

Soap	300	lbs.
Sal soda, 36°	200—225	lbs.
Dry alkali or soda ash	85—100	lbs.
Talc	50	lbs.

While mixing, the soap should be kept hot, if possible, by admitting steam into the jacket, and the sal soda also should be used hot. The effect of the soda ash is to absorb the moisture of the soap, thereby making the product harder and causing very quick drying. The soda ash should be pure, so that the water may not be discolored by it in use. The mixture may be run into frames to set, and afterwards cut into bars and dried.

After sufficient drying, the product is passed through the grinding mill, sifted and packed. For grinding, a number of different machines are used, but it is necessary to guard against heating in the mill, to avoid melting of the soap. A simple contrivance is a revolving sheet iron drum, perforated in the manner of an ordinary grater, against which the soap is held by any suitable means. The sieve should have suitable attachments for turning the coarse tailings back into the mill.

From the above description, the manufacture of a soap powder by half-boiling is self-evident, so we need not go into details regarding it. A variation, however, may be mentioned, which consists in using red oil (oleic acid) as the stock, and saponifying it by half-boiling, or by the cold process, with caustic lye or a solution of carbonate of soda, using in the first case rather less lye than is required for the complete saponification. While the soap is still liquid the soda is added, when, in consequence of the carbonic acid disengaged, the mass rises in a somewhat frothy, dry body, which is soon ready for the mill. Red oil being a fatty acid, it saponifies readily with carbonate of soda, and of course, the product is free from glycerine. In saponifying this stock the precaution, previously mentioned, of adding the red oil to the lye, instead of the reverse, must be observed, in order to prevent bunching of the materials.

In concluding it should be repeated that the foregoing has reference to the better grades of soap powder, as it is not within the province of this book to go into details regarding products which are discreditable to the manufacturer, as an instance of which we will only mention one of a number of formulas which have been highly lauded by parties who ought to know better, as follows: "40 ℔s. sal soda, 20 ℔s. caustic soda, 15 ℔s. silicate of soda, 2 ℔s. palm oil, 20 ℔s. water." Formulas of this kind may be considered valuable by their fortunate possessors, but we do not deem them in any way connected with *soap* making, nor calculated to serve as a basis for a successful business.

An ingenious variation, which is said to be practiced in some European countries, consists in boiling linseeds directly with caustic lye. The product is a thin linseed oil soap containing more or less extractive matter which causes strong frothing in use, creating the impression that the amount of soap present is much larger than it really is.

PART V.

Tables, Etc.

Caustic Soda and Caustic Potash Required for Making, or Contained in Lyes, of Different Strengths.

Lye.	Specific Gravity.	100 lbs. lye contain of Caustic Soda.	100 lbs. lye contain of Caustic Potash.
1° B.	1.0070	0.61 lbs.	0.90 lbs.
5° "	1.0360	3.35 "	4.50 "
8° "	1.0588	5.29 "	7.40 "
10° "	1.0746	6.55 "	9.20 "
12° "	1.0909	8.00 "	10.90 "
15° "	1.1163	10.05 "	13.80 "
18° "	1.1423	12.64 "	16.50 "
20° "	1.1613	14.37 "	18.60 "
25° "	1.2101	18.58 "	23.30 "
30° "	1.2632	23.67 "	28.00 "
35° "	1.3211	28.83 "	32.70 "
38° "	1.3585	32.47 "	35.90 "
40° "	1.3846	34.96 "	37.80 "
45° "	1.4545	41.40 "	43.40 "
50° "	1.5319	49.00 "	49.40 "

If these lyes are made of chemically pure caustic alkali the actual caustic content is expressed by the figures.

If the lyes are made of lower grades the *actual caustic* strength is proportionately decreased, as the grade of caustic alkali is lower.

The degrees on the hydrometer refer to a temperature of 60° F. In cooling from the boiling point to 60° F., lyes increase from 4½ to 5° B. in density.

Alkali Required for Saponification.

There are required for the complete saponification of	Caustic Soda. 77½ % Chem. Pure.	Caustic Soda. 77 %	Caustic Soda. 76 %	Caustic Soda. 74 %	Caustic Soda. 70 %	Caustic Soda. 60 %	Caustic Potash. Chem. Pure.
100 lbs. Cocoanut oil*	17.42 lbs.	17.53 lbs.	17.76 lbs.	18.24 lbs.	19.29 lbs.	22.5 lbs.	24.4 lbs.
100 " Tallow*......	13.95 "	14.04 "	14.22 "	14.61 "	15.44 "	18.2 "	19.54 "

*These calculations are theoretical, and made on the basis of very pure fat. Fats and oils that contain impurities will absorb correspondingly less alkali. The figures for grease, cotton seed oil, and other fats (except cocoanut oil) are nearly the same as for tallow. In practice for boiling soaps more alkali is required than stated above on account of at least some unavoidable waste. For cold-made or half-boiled soap the above proportions are substantially correct, as no lye is run away in their manufacture. Circumstances, of course, figure largely in actual practice.

TEMPERATURE OF WET STEAM AT VARIOUS DEGREES OF PRESSURE.

As the pressure in the steam boiler rises the temperature of the steam is increased, so that for operations intended to evaporate considerable water from the soap an increased steam pressure gives the fastest result.

TEMPERATURE. Degrees F.	PRESSURE. lb. per sq. inch.
32	.08
212	14.70
248	28.83
275	45.49
293	60.40
311	79.03
320	89.86
428	336.30

EXPANSION OF OILS BY HEAT.

When the quantity of oils and fats run into the kettle is regulated by measurement, the temperature of the stock is a not unimportant item, as in common with other liquids, oils expand by heat so much that, for instance, 1,000 gallons of oil at 32° F. will make 1,018 to 1,025 gallons at 75° F., according to the kind of oil.

Metric Weights and Measures.

1 Hectoliter (100 liters)	=	26.4175	U. S. gallons.
1 Liter	=	2.1134	American pints (= 61.024 cubic inches.)
1 Kilogram (1000 grams)	=	2.205	lbs. avoirdupois.
1 Gram	=	15.4384	grains.
1 Kilometer (1000 meters)	=	0.62138	mile.
1 Meter	=	39.3795	American inches.
1 cubic centimeter (c. c.)	=	16.23	minims.

The prefixes used in the metric system have the following meaning :

Kilo— meaning one thousand.
Hecto— meaning one hundred.
Deka— meaning ten.
Deci— meaning one-tenth.
Centi— meaning one-hundredth.
Milli— meaning one-thousandth.

Avoirdupois Weight.

1 ℔.	=	16 ounces	=	256 drachms.
		1 ounce	=	16 drachms.

The pound avoirdupois equals 7000 grains in weight. There is no grain in the avoirdupois weight—as found in some tables—but only one uniform grain (that of the troy weight) exists.

Troy (Apothecaries') Weight. (U. S.)

1 pound	=	12 ounces	=	96 drachms	=	288 scruples	=	5760 grains.
		1 ounce	=	8 drachms	=	24 scruples	=	480 grains.
				1 drachm	=	3 scruples	=	60 grains.
						1 scruple	=	20 grains.

Wine (Apothecaries') Measure. (U. S.)

The U. S. gallon contains 231 cubic inches and equals 0.83292 British gallon.

1 gallon	=	8 pints	=	128 fl. ozs.	=	1024 fl. drachms	=	61440 minims.
		1 pint	=	16 fl. ozs.	=	128 fl. drachms	=	7689 minims.
				1 fl. oz.	=	8 fl. drachms	=	480 minims.
						1 fl. drachm	=	60 minims.

Imperial Measure.

The Imperial (British) gallon contains 277.27384 cubic inches and equals 1 gallon 1 pint 9 fl. oz. 5 fl. drs. and 8 minims of the United States gallons.

1 gallon	=	8 pints	=	160 fl. ozs.	=	1280 fl. drachms	=	76800 minims.
		1 pint	=	20 fl. ozs.	=	160 fl. drachms	=	9600 minims.
				1 fl. oz.	=	8 fl. drachms	=	480 minims.
						1 fl. drachm	=	60 minims.

APPENDIX.

INTRODUCTION.

Not only is the formation of soap from fats and alkali a true chemical process, and therefore best explained by reference to the fundamental principles of chemistry, but the numerous raw materials employed, and the various stages of manufacture also offer many opportunities for profitable as well as interesting chemical observation. In late years soap makers have more and more taken up the study of this science, and with so good results that whereas the manufacture of soap was once enshrouded in mysteries, the soap maker of to-day at least understands the reasons underlying the facts that come daily under his practical observation. Formerly, attempts were numerous to improve the art of soap making by new processes, the impossibility of which would have been plain at once to every chemist; but in their stead chemistry has made possible improvements which, without this science, would undoubtedly never have been thought of. The manufacture of soda ash and caustic soda from salt, and the recovery of glycerine from spent lyes, are notable examples of this fact.

It is undoubtedly possible to be a practical soap maker without understanding even the first principles of chemistry, but it is also safe to predict that every practical soap maker would be *less dependent on chance* and would acquire a much clearer knowledge of his calling by familiarizing himself with chemistry, at least sufficiently to thoroughly understand those principles on which soap making is based.

The foregoing pages have been written with a view to cover the requirements of practical soap makers, whether they have any knowledge of chemistry or not, and it is not within the province of this book to teach the rudiments of that science. But many of the facts pointed out in these pages will acquire greater significance

and be more distinctly understood by the reader when viewed in the light of the teachings of chemistry.

Not only is this science of great use in aiding the practical manufacturer to properly understand his work, but it also gives him the means of conducting practical operations, and, in fact, his entire business to better advantage: It enables him to detect adulterations in the raw materials, to discover and remedy the causes of occasional irregularities in his work, to avoid waste, to work out improvements, and last, but not least, it places him in a position to judge intelligently of the practical value of new materials and methods.

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NOTE 1:

Alkalies are the oxides of the so-called "alkali metals," these being the metals that oxidize readily in the air, are lighter than water, and decompose the latter at ordinary temperatures with the liberation of hydrogen and the simultaneous formation of their hydroxides. In the case of ammonia (NH_3) it is considered that, when dissolved in water, it forms the hydroxide NH_4HO in which the radical "ammonium" (NH_4) is of metallic character in its chemical behavior.

Alkaline Earths may be defined as oxides of certain metals (called the alkaline earth metals), namely of calcium, strontium, and barium; magnesium may also be included in the group, although it has very little of an alkaline character. They derive their name from the fact that they resemble on one hand the oxides of the alkali metals, and on the other hand arrange themselves with the true earths.

NOTE 2:

Fats and oils are "glycerides," or ethers of glycerin. *Glycerin* is an alcohol, for the alcohols are those compounds that are formed when the radical HO is substituted for one or more atoms H in a compound of hydrogen and carbon; thus the hydrocarbon ethane, C_2H_6, forms the ordinary alcohol C_2H_5HO in the manner stated. Similarly the substitution of three atoms of H by as many groups HO in the hydrocarbon C_3H_8 forms the alcohol glycerin, $C_3H_5(HO)_3$. The alcohols therefore are the hydrates of the alcoholic radicals. *Ethers* may be simple or compound, the simple ethers being the oxides of the alcoholic radicals, formed by the action of acids on the alcohols, thus:

$$C_2H_5HO \quad \text{forms} \quad \left.\begin{matrix}C_2H_5\\C_2H_5\end{matrix}\right\}O$$

Ethyl hydrate=alcohol. Ethyl oxide=ether.

The compound ethers are formed by the double decomposition of an acid and an alcohol, as in the following example:

$$\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}O+\left.\begin{matrix}NO_2\\H\end{matrix}\right\}O=\left.\begin{matrix}H\\H\end{matrix}\right\}O+\left.\begin{matrix}NO_2\\C_2H_5\end{matrix}\right\}O$$

Ethyl hydrate	Nitric acid	Water	Nitric ether

From the action of fatty acids on glycerin in this manner the compound ethers, which constitute the fats and oils, are derived, thus:

$$\left.\begin{matrix}3C_{18}H_{35}O\\H\end{matrix}\right\}O+\left.\begin{matrix}C_3H_5\\H_3\end{matrix}\right\}O_3=\left.\begin{matrix}3H\\H\end{matrix}\right\}O+\left.\begin{matrix}(C_{18}H_{35}O)_3\\C_3H_5\end{matrix}\right\}O_3$$

Stearic acid	Glycerin	Water	Stearin

NOTE 3:

The organic acids may be considered as derived from the alcohols (as indeed occurs in making vinegar [—acetic acid], which belongs to the fatty acids— from alcohol), by replacing O for H_2;

$$C_2H_6O \quad : \quad C_2H_4O_2$$

Alcohol — Acetic acid

NOTE 4:

The formation of soap and separation of glycerine on boiling a fat with caustic lye is represented by the following equation:

$$\left.\begin{matrix}(C_{18}H_{35}O)_3\\C_3H_5\end{matrix}\right\}O_3+3NaOH=\left.\begin{matrix}3C_{18}H_{35}O\\Na\end{matrix}\right\}O+\left.\begin{matrix}C_3H_5\\H_3\end{matrix}\right\}O_3$$

Stearin	Caustic soda	Sodium stearate (Soap)	Glycerine

NOTE 5:

The decomposition, by water, of neutral soap into a mixture of alkaline and of acid soap, may be illustrated by the following:

$$3(C_{18}H_{35}O_2Na)+H_2O=C_{18}H_{35}O_2NaOHNa+C_{18}H_{35}O_2NaC_{18}H_{36}O_2$$

NOTE 6:

The principal fatty acids are the following:

		Found principally in:
Butyric acid	$C_4H_8O_2$..................	Butter.
Lauric acid	$C_{12}H_{24}O_2$..................	Cocoanut oil.
Myristic acid	$C_{14}H_{28}O_2$..................	" "
Palmitic acid	$C_{16}H_{32}O_2$..................	Lard, tallow, palm oil.

Stearic acid	$C_{18}H_{36}O_2$..................	Lard, talow.
Oleic acid	$C_{18}H_{34}O_2$..................	" "
Linoleic acid	$C_{16}H_{28}O_2$..................	Linseed oil.
Ricinoleic acid	$C_{18}H_{34}O_3$..................	Castor oil.

NOTE 7:

The influences at work in turning fats rancid have been made a study by many eminent investigators, but no final conclusion has been reached. It has been held—by Liebig and others—that the foreign admixtures, such as albumen, mucous, etc., in a fat acted as a kind of ferment; others considered that the impurities merely attract oxygen and yield it to the fats; according to another view (by Berthelot) moisture is the first cause of rancidity; and Virchow and others ascribe it to the action of certain micro-organisms. Ed. Ritsert, by a series of experiments, found that *when the air is excluded*, sterilized lard will not turn rancid, even if it contains moisture, and is subjected to sunlight. Nor did it become rancid when exposed to the air *and the light excluded. When exposed to both sunlight and air* the lard turned distinctly rancid within a week, but no bacteria could be found in the fat. It may occur that micro-organisms are found in rancid fat, as in so many other substances, but when such organisms were introduced into sterilized lard and the latter exposed to the sun, it developed more free fatty acids and yet the micro-organisms died. It seems to be established by these trials that sunlight and air together are able to cause rancidity of fats, and that micro-organisms are not concerned in the change. Ferments also do not seem to take part in it, for sterilized fat that had been heated to a temperature at which all known ferments are killed, turned rancid after exposure to light and sterilized air or oxygen. Fat freed from moisture turned even more rancid than fat charged with it, so that moisture does not appear to be so important a factor in the process as was supposed.

NOTE 8:

Sodium oxide and water combine according to the following formula to form caustic soda:

$$Na_2O + H_2O = 2NaOH,$$

and according to the atomic weights (Na=23, O=16, H=1) it follows that 62 parts NaO and 18 parts water, form 80 parts sodium hydrate.

NOTE 9:

The decomposition of soap by salts contained in hard water is shown by the following formula:

$$2C_{18}H_{35}NaO_2+CaH_2(CO_3)_2=Ca(C_{18}H_{35}O_2)_2+2NaHCO_3,$$

Sodium stearate	Calcium bicarbonate	Calcium stearate	Sodium bicarbonate

NOTE 10:

Caustic soda or lime are frequently employed to soften hard water when the hardness is caused by carbonates; the reaction which reduces the hardness is as follows:

$$CaH_2(CO_3)_2+Ca(OH)_2=2\ CaCO_3+2\ H_2O,$$

Calcium bicarbonate	Calcium hydrate	Calcium carbonate	Water

The bicarbonate of lime causing the hardness is by this reaction changed into the insoluble carbonate, which precipitates.

NOTE 11:

The reaction taking place in separating a potash soap by means of salt is a double decomposition, the hydrochloric acid of the salt combining with the potash, and the fatty acids combining with the soda. When carbonate of potash is added to a soda soap, some potash soap and carbonate of soda is formed. Both changes are due to the fact that when both soda and potash are present, combined with two acids, the potash has a tendency to combine with the stronger acid. Hydrochloric acid is stronger than fatty acids, and these are stronger than carbonic acid. However, when only fatty acids are present, and the soda and potash are both caustic, they seem to combine with equal preference for the several fatty acids.

NOTE 12:

The formula for both, silvic and pinic acid, is $C_{20}\ H_{30}\ O_2$, they being isomeric.

NOTE 13:

Soda ash and potash are made caustic by the action of quicklime by the withdrawal of carbonic acid, as follows:

$$Na_2\ CO_3+Ca\ (HO)_2=Ca\ CO_3+2\ Na\ HO$$

Carb. soda	Calcium Hydrate	Calcium Carbonate	Caustic soda

NOTE 14:

The decomposition of fat by means of heat and water (steam) into fatty acids and glycerine (compare also Note 2) is effected according to the following formula:

$$\left.\begin{array}{c}(C_{18}H_{35}O)_3\\ C_3H_5\end{array}\right\}O_3 + 3\,H_2O = 3\left.\begin{array}{c}C_{18}H_{35}O\\ H\end{array}\right\}O + \left.\begin{array}{c}C_3H_5\\ H_3\end{array}\right\}O_3$$

Stearin Water Stearic acid Glycerine

This reaction, it will be noticed, is very similar to that by which soap is formed when lye is employed instead of water, as explained in Note 4.

NOTE 15:

Soda ash and soda crystals consist essentially of carbonate of soda. The soda ash is anhydrous, and may be of very variable degrees of purity; the crystals are obtained by crystallizing them out from a strong solution of soda ash in water and are much purer than the soda ash from which they are made, but the alkali in them is combined with seven equivalents of water of crystallization.

"Caustic soda ash" is a carbonate of soda containing a proportion (more or less) of caustic soda. Ordinary ash contains but little caustic. Crystallized soda contains about 63% of water and 37% of carbonate of soda. The impurities of soda ash made by the Leblanc process of alkali manufacture consist chiefly of sulphate of soda, silicate of soda, common salt, caustic soda, carbonate of lime, sand, iron, etc. The product of the Ammonia process is very much purer, and free from caustic soda.

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